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EOS

Earth & Space Science News

DISSOLVED ORGANIC MATTER IN THE OCEAN CARBON CYCLE

Modeling Earth's Ever-Changing Surface

Pluto's Moons Nix and Hydra Show Their Faces

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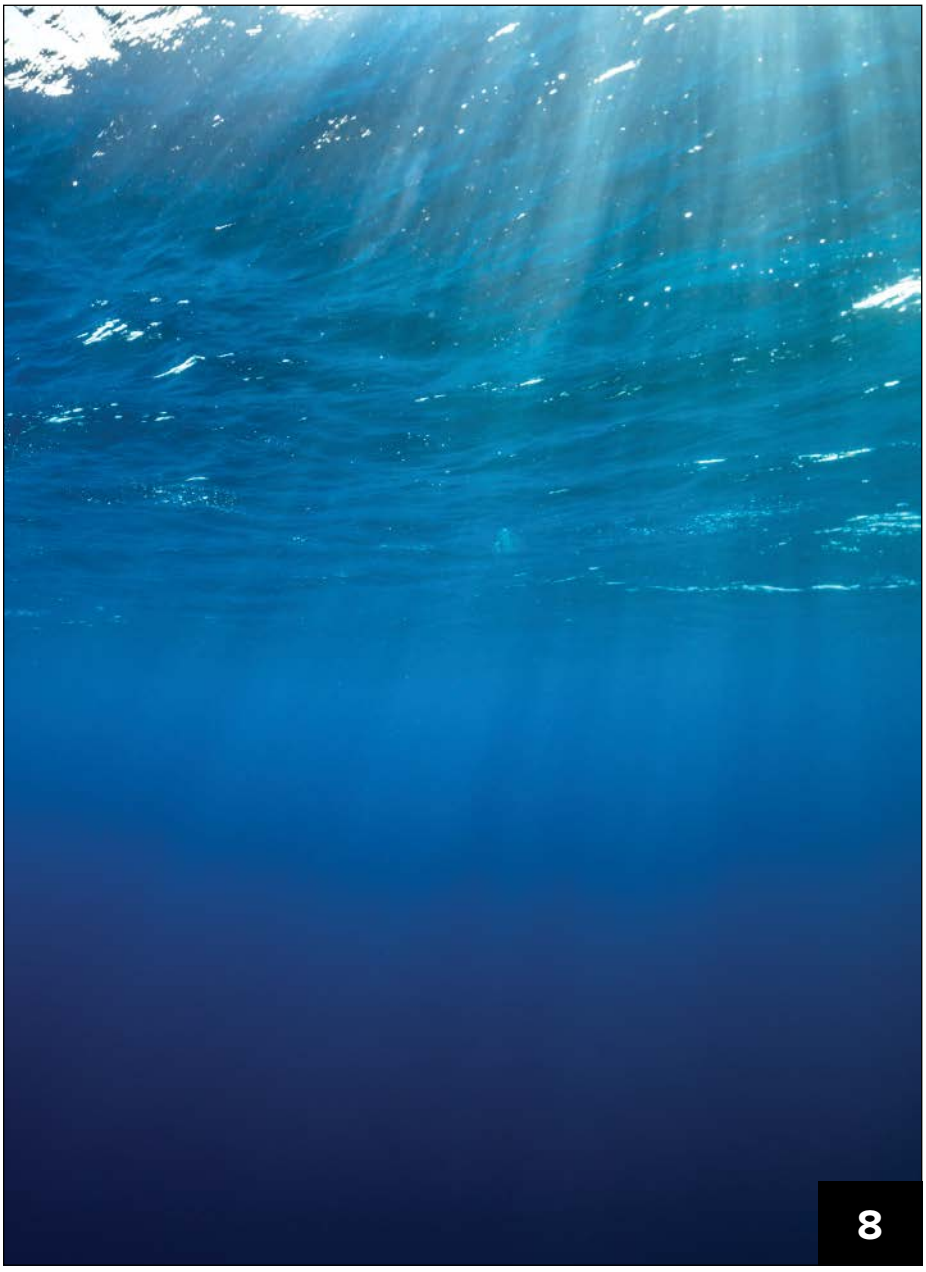

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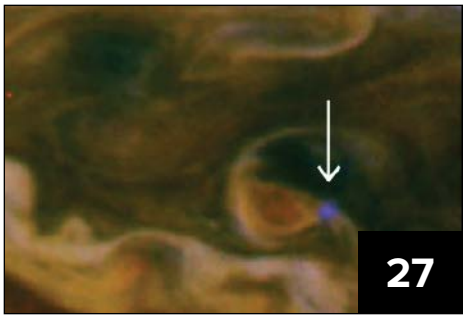

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Marine phytoplankton, such those in the *Cymbella* genus, are a major source of dissolved organic carbon in the ocean. Credit: Dennis Kunkel Microscopy, Inc./Visuals Unlimited, Inc.

Eos

Editor in Chief

Barbara T. Richman: AGU, Washington, D. C., USA; eos_ brichman@agu.org

Editors

Christina M. S. Cohen, California Institute of Technology, Pasadena, Calif., USA; cohen@srl.caltech.edu

Wendy S. Gordon, Ecologia Consulting, Austin, Texas, USA; wendy@ecologiaconsulting.com

Carol A. Stein, Department of Earth and Environmental Sciences, University of Illinois at Chicago, Chicago, Ill., USA; cstein@uic.edu

José D. Fuentes, Department of Meteorology, Pennsylvania State University, University Park, Pa., USA; juf15@meteo.psu.edu

David Halpern, Jet Propulsion Laboratory, Pasadena, Calif., USA; davidhalpern29@gmail.com

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Christine W. McEntee, Executive Director/CEO

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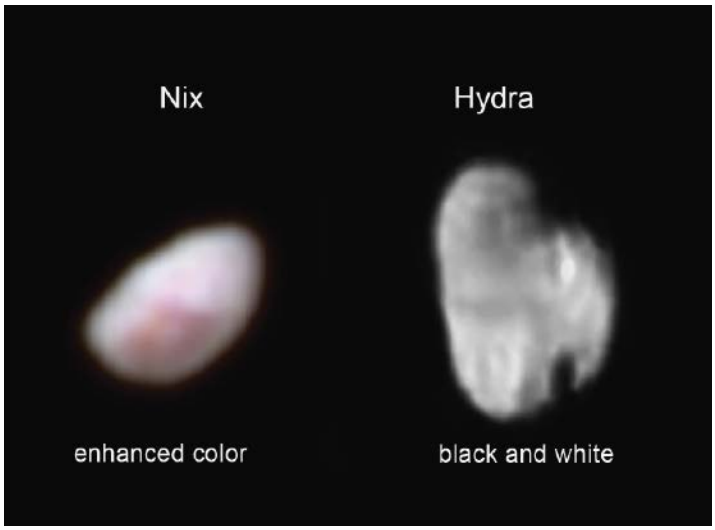
Pluto's Moons Nix and Hydra Show Their Faces

Pluto's moons Nix and Hydra appear in unprecedented sharpness in images released on 21 July from NASA's New Horizons mission. These images enabled scientists for the first to time to estimate the sizes of these tiny natural satellites: Nix (left) at 26 miles (42 kilometers) by 22 miles (36 kilometers) and Hydra (right) at 34 miles (55 kilometers) by 25 miles (40 kilometers).

Nix's portrait, imaged in enhanced colors, showed a reddish patch reminiscent of a bull's-eye. In a press release (see: http://bit.ly/NixHydra_PR), scientists said that they suspected the region could be an impact crater on the jelly bean–shaped moon but were awaiting additional data from the spacecraft to better understand what they'd observed.

The New Horizons spacecraft captured the images on 14 July while 102,000 miles (165,000 kilometers) from Nix and 143,000 miles (231,000 kilometers) from Hydra. Nix and Hydra's debut came on the heels of other detailed images of Pluto, taken during the spacecraft's historic Pluto flyby (see: http://bit.ly/PlutFlyby).

By **JoAnna Wendel,** Staff Writer



NASA/JHU APL/SWRI

Weak Shaking Lessened Nepal Earthquake Impact

Prakash Mathema/AFP/Getty Images

A woman inspects rubble from a house in Bhaktapur, on the outskirts of Kathmandu, that was severely damaged by the 25 April earthquake in Nepal. Despite widespread devastation from the quake, the magnitude 7.8 temblor generated shaking more typical of a smaller earthquake, scientists said at a June meeting of the International Union of Geodesy and Geophysics.

> "People knew how to conduct themselves. That must have been another factor in few lives lost."

The magnitude 7.8 earthquake that struck Nepal on 25 April killed more than 8800 people, injured another 23,000+, and destroyed at least 500,000 buildings.

But weak and limited ground shaking for a quake of such large magnitude helped keep its impact from being a lot worse, said scientists at a special symposium about the earthquake at the International Union of Geodesy and Geophysics (IUGG) general assembly in Prague, Czech Republic (http://bit.ly/IUGGPrague).

The earthquake "wasn't generating a lot of ground acceleration," symposium speaker Thorne Lay told *Eos*. "It just had very concentrated slip that was localized [and] that limited the areas that had the most shaking."

Lay, who directs the Center for the Study of Imaging and Dynamics of the Earth at the University of California, Santa Cruz, explained that the temblor "wasn't really jerky" because it was "a very narrow, smooth propagating rupture."

The shaking from the earthquake better matched what would have been expected from a magnitude 6 or 6.5 quake rather than from almost an 8, symposium convener Domenico Giardini told *Eos*. He serves as chair of seismology and geodynamics at the Institute of Geophysics at ETH Zurich, Switzerland, and is president of the International Association of Seismology and Physics of the Earth's Interior (IASPEI), a semiautonomous association of IUGG.

Seismic Risk Remains High

Giardini, Lay, and other speakers in the 27 June session noted that the seismic risk remains very high in the Kathmandu area, which lies along the earthquake-prone boundary where the Indian tectonic plate slowly pushes beneath the Eurasian plate.

The Nepal earthquake "actually ruptured an incredibly small segment of this plate boundary," said Kevin Furlong, a geosciences professor at Pennsylvania State University in University Park. Major earthquakes have occurred in the past along many segments of the boundary, he noted, but the short length of the rupture, which ended just north of Kathmandu, leaves many other locations along the plate boundary unrelieved of their stress and still capable of generating even stronger quakes. "There are no safe spots," he said.

Training May Have Saved Lives

Other session speakers suggested that to a limited degree, improvements in earthquake preparedness and building practices in Nepal helped lessen the number of deaths and amount of destruction from the quake.

Harsh Gupta, president of the Geological Society of India and past president of IUGG, told *Eos* that although the structural damage to Nepal was what one would expect from a magnitude 7.8 earthquake, the loss of human lives was much less than from similar earthquakes. He partially attributed this decrease to earthquake safety training.

An earthquake awareness campaign takes place in the city every year, so "people knew how to conduct themselves," he said. "That must have been another factor in few lives lost."

Training of engineers and masons in Nepal over the past several decades to design and build more earthquake-resistant structures "definitely had an effect," added Mohsen Ghafory-Ashtiany, president of the Iranian Earthquake Engineering Association. "But it was not as effective as we would expect."

Engineers and scientists have not been successful in Nepal at translating their knowledge into "simple, doable, affordable, culturally acceptable solutions," said Ghafory-Ashtiany, who chairs IASPEI's Commission on Earthquake Hazard, Risk and Strong Ground Motion. Although Nepal has building codes and a master plan for dealing with major disasters, he told *Eos*, there is a big gap "between implementation and theory."

By **Randy Showstack,** Staff Writer

McNutt Nominated as President of National Academy of Sciences

Marcia McNutt, a marine geophysicist who served as president of AGU from 2000 to 2002, has been nominated by the Council of the U.S. National Academy of Sciences (NAS) to succeed Ralph Cicerone as its next president, the academy announced on 6 July.

She is expected to be the sole nominee for president and, if her nomination is ratified, would be the first woman president of NAS since its founding in 1863, according to NAS spokesperson William Kearney.

McNutt told *Eos* that as NAS president, she would make climate change a top priority. Her goal "would be to spur serious action on mitigation and adaptation, showing U.S. leadership in technology choices and policy solutions that can be widely adopted," she said.

She also pledged to keep NAS "the place where the nation can turn to for an unbiased answer to a scientific question. I strongly believe that science should not dictate to society what to do, but can only describe the likely results of various choices, allowing clearer decisions to be made."

McNutt pledged to keep NAS "the place where the nation can turn to for an unbiased answer to a scientific question."

Long History of Leadership and Academic Service

McNutt has served as editor in chief of the *Science* family of journals since May 2013. From 2009 to 2013 she was director of the U.S. Geological Survey. Previous positions include president and chief executive officer of the Monterey Bay Aquarium Research Institute and professor of geophysics at Stanford University.

In 2005, McNutt was elected to the National Academy of Sciences. Since 1984, she has served on more than 30 committees and boards of the National Academies of Sciences, Engineering, and Medicine. She is a fellow of AGU, the Geological Society of America, the American Association for the Advancement of Science, and the International Association of Geodesy.

McNutt also received AGU's Macelwane Medal in 1988, for research accomplishments by a young scientist, and AGU's Maurice Ewing Medal in 2007 for her significant contributions to deep-sea exploration.

In an interview with *Eos*, current NAS president Ralph Cicerone praised McNutt's leadership skills and experience. He named a host of issues he could see her tackling in the new post, from transparency of data and better funding for federal science agencies to sustainability, cybersecurity, national goals for space exploration, and more.

It is symbolically important that McNutt would be NAS's first woman president, he added. But at first, "It didn't hit me in the face that hard because I've just regarded Marcia as a colleague—and so many other women like Marcia as colleagues," Cicerone explained.

Cicerone said that he will step down, after 11 years as NAS president, before the end of his second 6-year term to pursue other interests, including conducting more research.

Unforeseen Consequences of Missing Committee Meetings

Reflecting on receiving the nomination, McNutt told *Eos* that she had originally been a member of the nominating committee for the next NAS president. "I had to miss the first meeting because I had a conflict. After the first meeting, the chair asked if I would be willing to step off the committee to become a candidate instead."

Being chosen seemed like a long shot to her, but she welcomed the turnabout. "I was honored simply to have my name discussed in the same association with so many distinguished scientific leaders," she said.

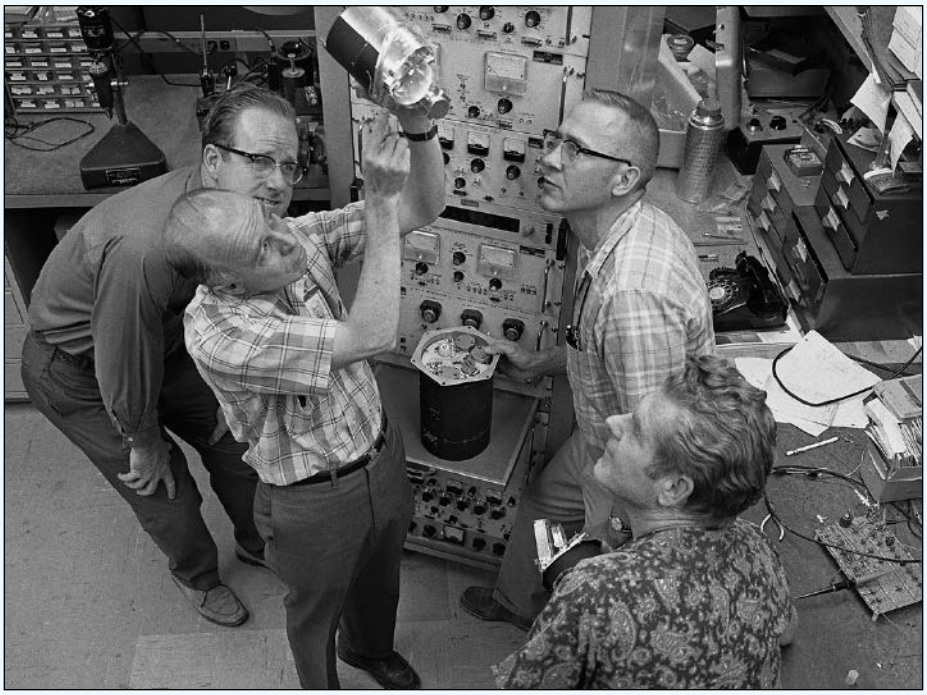
McNutt's nomination will be presented to the full NAS membership for ratification from 15 December 2015 to 31 January 2016. Cicerone will step down as NAS president on 30 June 2016, after which, if ratified, McNutt would succeed him.

AAAS

Marcia McNutt

By **Randy Showstack,** Staff Writer

Samuel J. Bame Jr. (1924–2014)



Los Alamos National Laboratory

Sam Bame (center) in 1970, surrounded by (from left to right) Harry Felthauser, Jack Asbridge, and J. Paul Glore, as he explains a detail of one of the earliest space plasma instruments using an engineering model. The instrument, which he designed and developed, was flown on a Vela spacecraft in the early 1960s.

Sam emerged as one of the most successful, innovative, and prolific experimenters studying space plasma physics.

Samuel J. Bame Jr., one of the early pioneers in space physics, passed away 14 December 2014 in Albuquerque, N.M.

Beginning with his work in the Atomic Energy Commission's Vela program, Sam emerged as one of the space community's most successful, innovative, and prolific experimenters studying space plasma physics. His plasma experiments using various types of spherical section electrostatic analyzers were flown on the Vela 2, 3, 4, 5, and 6 satellites; on the Interplanetary Monitoring Platform 6, 7, and 8 satellites; on the International Sun-Earth Explorer 1, 2, and 3 satellites; on Ulysses and the Advanced Composition Explorer; and on a series of eight geosynchronous satellites. Together, these sensors have returned more than 82 satellite-years of data.

Sam's experiments led to fundamental discoveries about space plasmas. These include the discovery of the plasma sheet and plasmoids in the geomagnetic tail as well as magnetic reconnection at the Earth's magnetopause and in the solar wind. His instruments also detected heavy ions, non-Maxwellian structure in velocity distributions, thermal anisotropies, double ion beams, and coronal mass ejections in the solar wind, as well as the three-dimensional structure of the wind and its temporal and spatial evolution. In addition, his sensors discovered mechanisms of ion and electron heating at the Earth's collisionless bow shock along with numerous quantitative characterizations of magnetospheric structure and dynamics at geosynchronous orbit.

Early Interest in Science

Sam was born on 12 January 1924 in Lexington, N.C. As a youth, he was fascinated by science, particularly astronomy. He began his college education at North Carolina's Catawba College before entering the Army in 1943.

His aptitude for physics led to his selection for the Army Specialized Training Program at Pennsylvania State University in 1943–1944, and he served in the Proximity Fuse Program and Ordnance Technical Intelligence in the United States, the Philippines, and Japan in 1945–1946. After the war, he earned his bachelor's degree in physics from the University of North Carolina and earned his master's and Ph.D. degrees in nuclear physics from Rice University in 1951.

During his time at Rice, Sam won a Humble Oil Fellowship that allowed him to spend a summer interning at Los Alamos Scientific Laboratory in New Mexico. After graduation, he joined the scientific staff at Los Alamos, where he spent his entire professional career. His early years there were devoted to low-energy nuclear physics, but he shifted his attention to space physics as the Space Age began.

Space Physics at Los Alamos

During his 40-year career at Los Alamos, Sam served as principal investigator for more than 60 neutron and plasma experiments that he conceived, designed, and implemented. All 60 were flown in space.

In the first successful flight of NASA's Scout rocket program, Sam made measurements of the relatively low-energy protons trapped in the outer Van Allen radiation belt. In a series of three rocket flights from 1959 to 1961, he made some of the first measurements of the neutron spectrum and neutron albedo above the atmosphere. The neutron detectors he developed for the Vela and follow-on satellite programs have provided continuous, critical monitoring support for the Nuclear Test Ban Treaty since 1963.

An Inspirational Scientist and Mentor

Sam was a mentor and an inspiration to younger scientists, such as the four of us, whose careers were launched and sustained by the rich data sets his instruments returned. The knowledge, skill, and care he brought to his work have left a truly rich legacy.

One of us (Dave McComas), whose desk was located in Sam's lab, recalls learning about the design and development of flight hardware as a young physicist. It was a true apprenticeship, similar to that of a young tradesman moving into the master's workshop to learn a craft.

Sam's attention to the careful design of his instruments taught us the utility and fundamental need for controlling and measuring, where possible, all backgrounds that affect the data. He promoted an open scientific environment that often led to lengthy, animated discussions of central scientific questions raised by the data from his instruments. The resulting "chatter" in the halls was a distinguishing and vital trait of the space plasma team at Los Alamos.

Sam served on a number of advisory groups for NASA over the years, was a Fellow of Los Alamos National Laboratory and the American Geophysical Union, and authored more than 400 scientific papers.

He was preceded in death by his wife of 44 years and is survived by his three daughters and four grandchildren. Sam will be dearly missed by his many friends and colleagues.

By **Bill Feldman,** Planetary Science Institute, Tucson, Ariz.; **Jack Gosling,** Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder; **Dave McComas,** Southwest Research Institute, San Antonio, Texas; email: dmccomas@swri.edu; and **Michelle Thomsen,** Planetary Science Institute, Tucson, Ariz.

Coping with Future Water Woes in the Western United States

Water Scarcity in the West: Past, Present, and Future
Davis, California, 6–7 April 2015

Alejo Kraus-Polk

California's New Melones Lake, photographed in December 2013, shrunk by prolonged drought.

Human existence in the West, where users compete for limited surface water and diminishing groundwater reserves, has always been challenged by water scarcity. As much of the western United States enters a fourth year of drought, adapting to increasing water scarcity is paramount.

A recent conference brought together water and climate experts to discuss this challenge. Held at the University of California, Davis, the conference aimed to foster discussion among competing stakeholders and identify methods for coping with future water scarcity.

A Focus on California and on Water Markets

During conference discussions, experts in hydrology, climatology, economics, environmental history, geography, and policy attempted to characterize water scarcity, first through time (from the perspectives of history, paleoclimate, and climate prediction) and second across sectors—ecosystems, urban, and agriculture. They also discussed strategies communities have used to cope with water scarcity.

Much discussion focused on California. Speakers noted major inadequacies in the legal framework for monitoring and regulating water in the state, especially groundwater. Some, including California Secretary for Natural Resources John Laird, floated the idea of eliminating established water rights. As in Australia, prior appropriation could be replaced with tradable shares of a flexible total allocation. Other speakers—primarily the economists present—promoted water markets as a way to efficiently reallocate water to those who need it most, without disrupting the current rights system.

> Although water markets could become a major component of the solution, the system would need to be transparent.

Although water markets could become a major component of the solution, the system would need to be transparent, meeting attendees agreed. Water basins in the West would need to be divided into trading zones determined with concern for environmental impacts, with a formalized, regulated market to disseminate price information. Critically, participants concluded that an incomplete water market structure coupled with uncertainties about the hydrologic system would impede rational water management.

Scarcity Under a Changing Climate

Climate scientists and hydrologists focused on examining the drought in terms of the past and defining water scarcity under climate change. Although the current drought may not be extraordinary in the context of the West's paleoclimate record, persistent pressure events, such as atmospheric ridging in the Pacific Northwest that diverts the winter storm track northward, are likely to be more common with global warming. Integrated atmospheric and hydrologic modeling can improve predictions of climate change impacts on water resources.

California Lags Behind in Water Resource Policy

The conference highlighted the fact that California trails other states in water management and policy. Patricia Mulroy, former general manager of the Southern Nevada Water Authority, emphasized that California has less resources information, less transparency, and a weaker watershed consciousness than other western states.

Meeting participants agreed that improved public information about groundwater usage and the formation of a regulated central clearinghouse for water transfers are the first steps toward better management. Attendees also agreed that the West needs to define itself as part of an interstate watershed community, with better monitoring and accountability.

For details more details, see the conference's website (http://bit.ly/westH2oscarcity).

Acknowledgments

The conference was funded by the National Science Foundation (NSF). Ellen Bruno, Lauren Foster, Katherine Hoeberling, Alejo Kraus-Polk, Stephen Maples, Matthew Renquist, Stacy Roberts, and Will Turner IV of the Climate Change, Water, and Society Integrative Graduate Education Research Traineeship (CCWAS IGERT) at the University of California, Davis, organized the conference and contributed to this article, with support from Graham Fogg, Carole Hom, the CCWAS IGERT, and NSF grant DGE 1069333.

By **Ellen Bruno,** Agricultural and Resource Economics, University of California, Davis; email: embruno@ucdavis.edu

DISSOLVED ORGANIC MATTER IN THE OCEAN CARBON CYCLE

By D. A. Hansell and C. A. Carlson

Controversy leads to a better understanding of carbon cycling through a massive pool of organic matter dissolved in Earth's oceans.

Earth's deep oceans contain almost as much carbon in the form of dissolved organic molecules as the planet's atmosphere contains in the form of carbon dioxide (CO_2). Given the dynamic nature of this pool, it was likely a major player in global climate over geologic time scales. Evidence suggests that sequestering large amounts of dissolved organic carbon in the deep ocean may have helped bring the planet back from past warming episodes similar to the one humans are causing now.

Could today's oceans pull off another such climate rescue? Certainly not on the timeline we'd like, but a quarter century of research has scientists poised to make major progress toward understanding how the system works.

The road to this point was not always smooth; just a few decades ago, a shocking study threw scientists' entire understanding of dissolved organic carbon in the ocean into doubt. Efforts to test the then new, incredible, and, finally, erroneous data led to a deeper understanding of how the ocean sequesters carbon.

A Surprise Result Initiates a Controversy

In the mid-1980s, ocean scientists believed that dissolved organic carbon (DOC) remained mostly biologically inactive and did not vary much throughout the ocean depths. Given that the pool of carbon was not considered particularly dynamic compared with nutrients and oxygen, it was considered by many to be boring and, as a result, was little studied.

Then came a surprise: *Sugimura and Suzuki* [1988] reported 2–5 times larger surface ocean DOC concentrations than others had previously observed. This stunning result hinged on a new analytical technique for measuring marine DOC by high-temperature catalytic oxidation. In this technique, DOC in seawater is oxidized at high temperature and the CO_2 generated is measured.

The results indicated significant variability in DOC from the surface ocean through to the greatest depths. If the results were correct, DOC was far from "boring," instead being central to the ocean's carbon cycle.

Troubling Implications

Many scientists took the results at face value in part because *Sugimura and Suzuki* [1988] showed a strong inverse relationship between their measured DOC concentrations and estimates of the oxygen utilized throughout the ocean's water column. Such an inverse relationship could be seen as consistent with what might be expected in nature: Oxygen was consumed while DOC was removed by DOC-consuming bacteria.

But if the deep ocean's oxygen consumption was primarily due to DOC consumption, the result was inconsistent with the prevailing biological pump model of the

ocean, whereby microbial oxidation of falling biogenic particles dominated oxygen consumption. The relationship also required that DOC follow oxygen into the deep ocean interior by the same mixing pathway: Oxygen-enriched and DOC-enriched surface ocean waters get carried with vertically overturning ocean circulation to great depths, largely at high latitudes. Accordingly, abyssal microbes must be surviving largely through the consumption of DOC and oxygen as the deep ocean layers circulate globally.

Overturning longstanding paradigms (i.e., that the biological pump, as exemplified by sinking biogenic particles, dominated deep oxygen consumption) is never easy; thus, despite the excitement generated by the new data, a controversy was born.

The community was divided and in angst. The discovery challenged much of what ocean scientists thought they knew about the intersection of ocean biology, chemistry, and the carbon cycle; many were left to wonder about their career's body of work, which was being so severely challenged by these surprising results. One pair of scientists [*Williams and Druffel*, 1988] summarized the community's deep divisions on the issue, writing, "These elevated concentrations, as yet unconfirmed, have been accepted as gospel by some, as heresy by others."

The situation became so tense that during a meeting of scientists tasked with testing the new methods and findings, a National Science Foundation program manager was seen pounding a table and demanding, "You guys need to figure this out!"

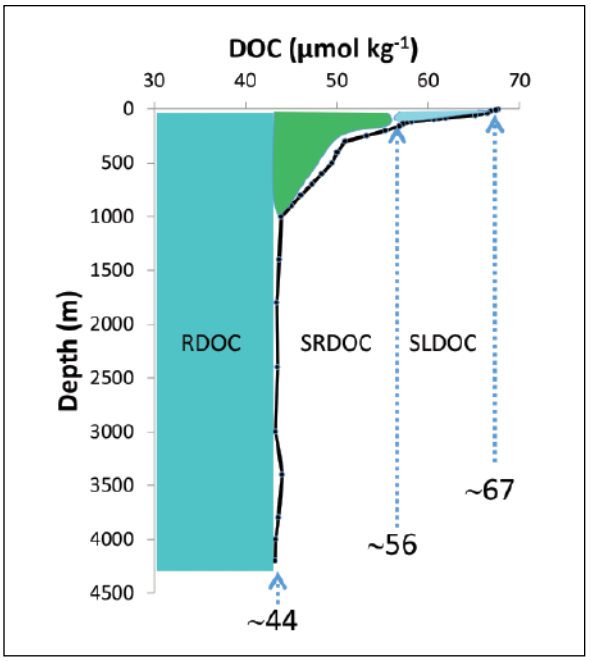


Fig. 1. Dissolved organic carbon (DOC) profile (solid line, with sampling depths from August 2008 indicated) and fractions (shaded regions) assigned in the western Sargasso Sea, in micromoles per kilogram. Concentration boundaries of the fractions shown are approximate. RDOC, refractory DOC; SRDOC, semirefractory DOC; SLDOC, semilabile DOC.

What Is Correct?

The marine chemistry community quickly organized itself to test the reliability of *Sugimura and Suzuki*'s [1988] fascinating yet troubling data [see *Hedges and Lee*, 1993].

Scientists found it difficult to reproduce the analytical technique itself because of the difficult-to-attain catalyst used in the "homemade" instrumentation of *Sugimura and Suzuki* [1988]. In addition, analytical expertise had to be quickly developed to actually use the instruments; a lack of agreement between a challenging scientist's results and those stunning new data could be laid at the challenger's feet with "your analytical skills are simply inadequate!"

Who was to judge irreproducibility? Was irreproducibility due to the challenger's uncertain analytical skills or due to problems at the origin of those stunning data?

In the early 1990s, a large community effort mobilized to standardize and optimize high-temperature combustion methodology. After numerous laboratory intercomparison exercises [*Sharp et al.*, 2002] and considerable effort and expense, a number of scientists, including Suzuki himself [*Suzuki*, 1993], deemed the 1988 results irreproducible.

Although much about this experience proved unfortunate, costly, and exhausting, the focused effort and resulting methodological improvements offered, for the first time, the ability to precisely measure small DOC concentration changes within a relatively large pool, thus opening the door to a proper evaluation of DOC in ocean biogeochemistry. Although scientists concluded that the original paradigm of a biological pump driven primarily by sinking particles survived its challenge, the improved DOC methodology produced valuable insights on the full nature of the biological pump, which indeed included an important role for DOC.

A Panoply of Carbon Compounds

Moving ahead more than 2 decades, scientists now have a much more nuanced picture of the forms organic carbon takes in the ocean. DOC comprises a myriad of compounds [*Repeta*, 2015] exhibiting a spectrum of biological reactivities, from the most easily altered (turnover rates of minutes to days) to the most inert (turnover rates of millennia; Figure 1). As such, depending on the fraction of interest, marine DOC has biological and ecological significance as well as biogeochemical implications for carbon export and sequestration within ocean basins.

The most easily consumed DOC pool—with an estimated global production of around 15 to 25 petagrams (1 petagram = 1 billion metric tons) of carbon each year yet an inventory of less than 0.2 petagram because microbes consume it as fast as it is produced [*Hansell*, 2013]—has the most biological relevance. The pool supports the energy and nutrient needs of vast populations of marine heterotrophic microbes.

This biologically available fraction includes simple compounds such as sugars and amino acids, which turn over on time scales of hours

Marine phytoplankton, such those in the Cymbella *genus, are a major source of dissolved organic carbon (DOC) in the ocean. They release DOC as they grow and get consumed through numerous foodweb interactions.*

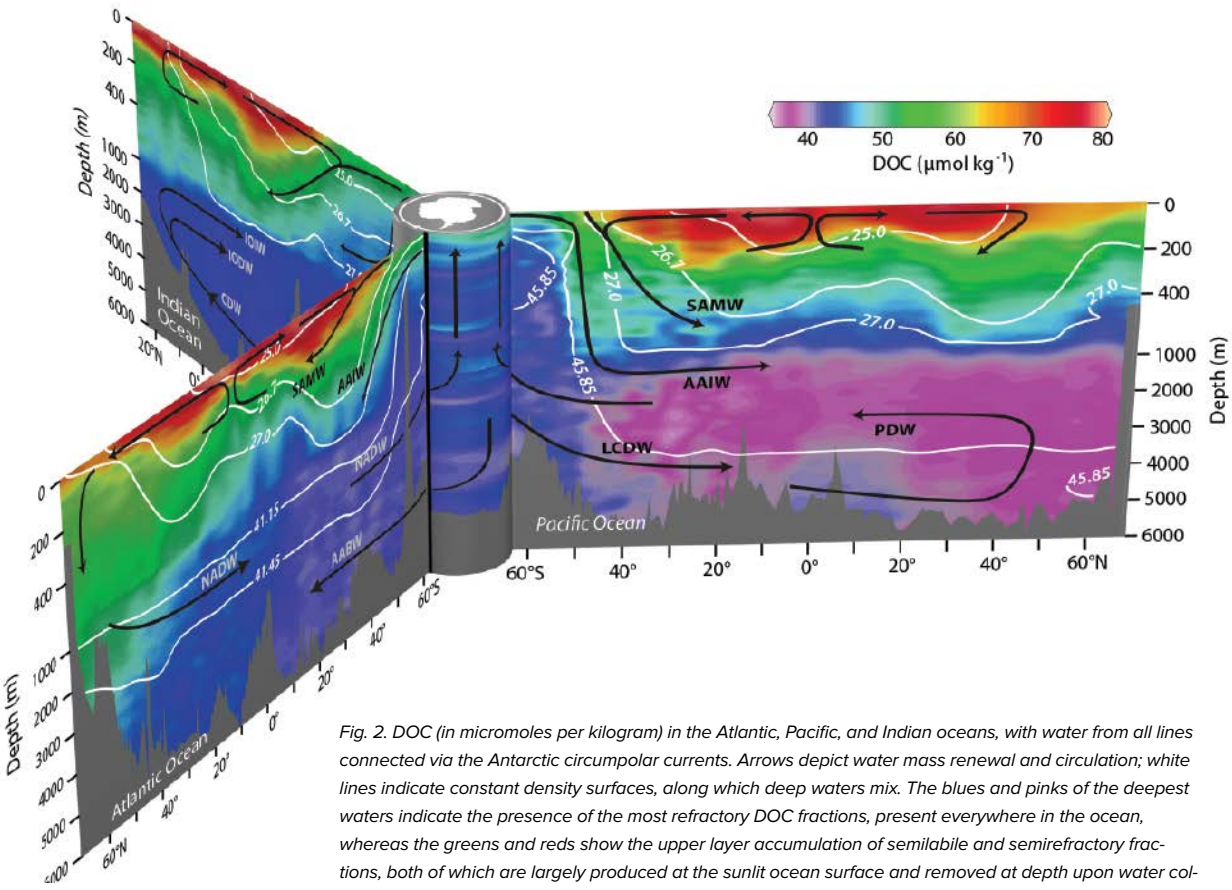


Fig. 2. DOC (in micromoles per kilogram) in the Atlantic, Pacific, and Indian oceans, with water from all lines connected via the Antarctic circumpolar currents. Arrows depict water mass renewal and circulation; white lines indicate constant density surfaces, along which deep waters mix. The blues and pinks of the deepest waters indicate the presence of the most refractory DOC fractions, present everywhere in the ocean, whereas the greens and reds show the upper layer accumulation of semilabile and semirefractory fractions, both of which are largely produced at the sunlit ocean surface and removed at depth upon water column overturn. AABW, Antarctic Bottom Water; AAIW, Antarctic Intermediate Water; CDW, Circumpolar Deep Water; IODW, Indian Ocean Deep Water; IOIW, Indian Ocean Intermediate Water; LCDW, Lower Circumpolar Deep Water; NADW, North Atlantic Deep Water; PDW, Pacific Deep Water; SAMW, Subantarctic Mode Water. Credit: Hansell *[2009].*

to days. With this fast turnover, the pool's contribution to carbon sequestration is inconsequential.

Biologically unavailable (recalcitrant) DOC fractions (Figure 1), summing to around 660 petagrams, constitute the sequestration capacity of the pool; this is the DOC that actually accumulates in the ocean (Figure 1). These fractions have a range of lifetimes.

Those with remineralization time scales reaching decades (the semilabile and semirefractory DOC fractions of Figure 1) contribute to carbon export from the surface to depths through overturning circulation, as seen in the downward transport of DOC in the far northern North Atlantic (Figure 2). These fractions, holding 20 petagrams of carbon, deliver that carbon from surface waters to the deep ocean at a rate of around 2 petagrams per year, representing the fate of around 20% of global ocean net community production.

The longest-lived fraction (termed refractory DOC in Figure 1) holds a carbon mass of around 640 petagrams. With average ages reaching 6000 years [*Bauer et al.*, 1992], this fraction sequesters carbon on millennial time scales. The gradient in concentrations of this old material, ranging from nearly 45 micromolar in the deep North Atlantic to 35 micromolar in the deep Pacific (Figure 2), requires DOC removal along the path of deep current flow in the global ocean. Whether these removal processes are due to biological or nonbiological processes is unknown.

Identifying the controls on DOC accumulation and its removal in the ocean is required before we can reply to our program manager that "we finally figured it out!"

Lessons Learned

Scientists now view marine DOC as one of Earth's greatest reservoirs of bioactive and exchangeable carbon, comparable in size to the atmospheric CO_2 reservoir. We now know that biological and biogeochemical processes can alter the production, removal, and storage of ocean DOC, with important implications for oceanic and atmospheric carbon exchange.

In addition, the pool is highly dynamic in the carbon cycle, cycling through the system on time scales ranging from seconds to millennia. Finally, we have learned that DOC feeds vast deep-ocean microbial populations, playing a role in controlling microbial diversity.

Challenges Ahead

The demand to understand DOC has escalated with time, creating new challenges and opportunities [*Hansell and Carlson*, 2015].

A major challenge is to determine the role the DOC reservoir plays in regulating Earth's climate [*Ridgwell and*

Arndt, 2015]. As much as 500 times more organic carbon may have been dissolved in the ocean during the Neoproterozoic Era (1000–543 million years ago; see *Rothman et al.* [2003]), and more than twice as much as at present may have been held in the deep ocean during the Paleocene and Eocene epochs (~65–34 million years ago), perhaps serving as the carbon reservoir being released to the atmosphere as CO_2 to drive the brief but regular warm events of that era [*Sexton et al.*, 2011].

Comparing those climates to ours today may elucidate the potential of our oceans to serve as a natural capacitor for carbon storage and release over geologic periods, giving up its carbon to the atmosphere as CO_2 to drive warm periods and pulling it back to force cool phases.

The research community is determining how DOC sources and sinks—both biotic and abiotic—operate today; this knowledge is required to understand mechanistically DOC's role in past and future oceans. Vast opportunities for discovery await.

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Author Information

D. A. Hansell, Department of Ocean Sciences, University of Miami, Miami, Fla.; email: dhansell@rsmas.miami.edu; and **C. A. Carlson,** Department of Ecology, Evolution and Marine Biology, University of California, Santa Barbara

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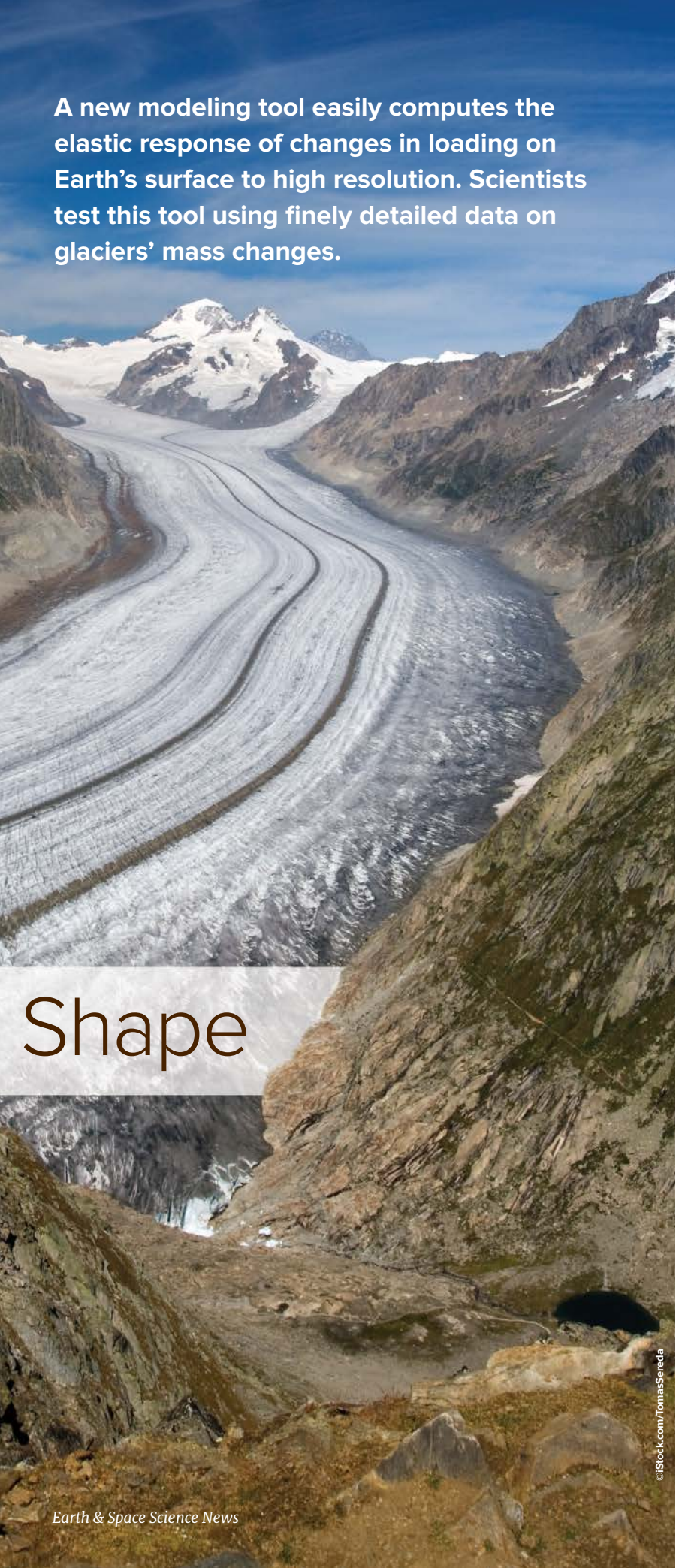
ON THE REBOUND

Modeling Earth's Ever-Changing

By Daniele Melini, Pascal Gegout, Matt King, Ben Marzeion, and Giorgio Spada

A new modeling tool easily computes the elastic response of changes in loading on Earth's surface to high resolution. Scientists test this tool using finely detailed data on glaciers' mass changes.

Shape



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Switzerland's Aletsch glacier, the largest glacier in the Alps. Thinning glaciers across the world, such as this one, don't just erode landscapes as they cut; their weight deforms the crust below them as they flow and melt.

Rock solid though it may be, Earth's surface is constantly morphing. Like a tennis ball hit relentlessly, the Earth deforms endlessly as atmosphere and oceans push and pull on its surface, glaciers grow and melt, ocean tides surge, mountains erode, and sediment piles up.

Some of these changes occur almost instantaneously, whereas others can take decades, centuries, or longer to play out as slow viscous flow takes place under the crust. In the same way that tides ebb and flow, rocks compress and expand instantaneously through storage and release of elastic energy. Much slower deformation also occurs when a large mass shifts on top of the surface, for instance, after a glacier retreats, and it takes time for the Earth's viscous layers underlying the crust to adjust.

Regardless of time scale, the largest elastic deformation of the crust is focused very near places where mass changes are occurring. Therefore, to accurately represent how Earth's surface responds to phenomena ranging from tides shifting to glaciers melting, numerical models need to have high spatial resolution.

To address this need, we developed the Regional Elastic Rebound Calculator (REAR), a new open-source software tool that performs fast, high-resolution elastic computations associated with any load change. We illustrate how REAR can be used with finely detailed data on glaciers' mass changes.

What Do Models of Glacial Deformation Need?

Scientists can study Earth's deformation to gain insights into how massive features on the surface are changing [*Khan et al.*, 2007; *Argus et al.*, 2014]. This study may also yield a deeper understanding of the structure and composition of lower layers such as the asthenosphere, the viscous upper layer of Earth's mantle [*Ito and Simons,* 2011].

Elastic deformation signals are particularly large, and often highly time variable, near thinning glaciers in Greenland, Svalbard, Alaska, and Antarctica. This deformation can complicate studies attempting to validate models of how the crust adjusts over long time scales in response to the melting of ice sheets since the Last Glacial Maximum (~20,000 years ago). Scientists studying glacial melt therefore need an effective model of short-term glacier-related deformation so that it can later be separated from long-term trends of the crust's response to the last ice age.

A Sharper View

Until recently, open software tools for computing elastic deformation have dealt mainly with elastic effects related

to ocean tides (e.g., SPOTL [see *Agnew*, 1997]). Other tools represent Earth's surface and subsurface at low spatial resolutions, which smears signals over unrealistically large regions (e.g., ALMA [see *Spada*, 2008]).

REAR offers geophysicists unprecedented realism and precision in representing Earth's surface deformation. The software takes advantage of the solution of equilibrium equations for a simplified model of Earth known as the solid, nonrotating, elastic and isotropic, layered, compressible spherical Earth model [see, e.g., *Gegout et al.*, 2010]. These equations describe how an elastic medium reacts when horizontally or vertically pushed or stressed or attracted by the material above it.

Setting up the Problem

Geophysicists express the elastic response to a localized surface load in terms of a set of load-deformation coefficients (LDCs). These coefficients represent the deformations and gravitational variations induced by specific loads distributed over the surface of the globe.

To compute the LDCs [*Gegout et al.*, 2010], scientists solve equations to find equilibrium between gravity's downward pull and elastic deformation's outward push while considering the physical properties of the Earth's layers. Site-dependent LDCs account for local composition and thickness—important factors because the crust deforms differently if made of thin or thick sediments or of hard crystalline rocks.

A Two-Step Process

REAR calculates the Earth's response to surface load variations in two distinct steps. First, the program computes how the surface would deform elastically in response to a disk-shaped load as a function of the distance from its center. This computation generates elementary response functions (ERFs), which are evaluated using user-supplied LDCs. These LCDs can be either globally averaged or regional, depending on the specific problem requirements.

In the second step, REAR combines the ERFs with a user-defined model of the surface mass variation to compute geodetic observables on a grid or at specified locations. In its current implementation, REAR requires that the mass model grid hosts elements the same size as those used to compute the ERFs.

Putting the Method to Use

The images in Figure 1 depict the kinds of results REAR can produce. In Figure 1a, arrows show how Earth's surface responds to the melting of glaciers across Alaska; Figures 1b and 1c show how it responds to glacial melting in the Alps.

Both simulations assume a constant rate of glacial mass loss between the periods of 1990/1991 and 2010/2011. The example illustrates all three basic outputs of REAR: vertical rates of uplift (or subsidence), horizontal rates of deformation, and the rate of change of the height of the geoid, which is the shape considered by geodesists to be Earth's true shape, defined by what the ocean's surface looks like under the influence of Earth's gravitation and rotation alone.

We reconstructed mass changes for the glaciers of the Randolph Glacier Inventory—a globally complete collection of the digital outlines of glaciers, excluding ice sheets [*Pfeffer et al.*, 2014]. We then used the glacier global surface mass balance model of *Marzeion et al.* [2012] and observed gridded temperature and precipitation anomalies [*Harris et al.*, 2014].

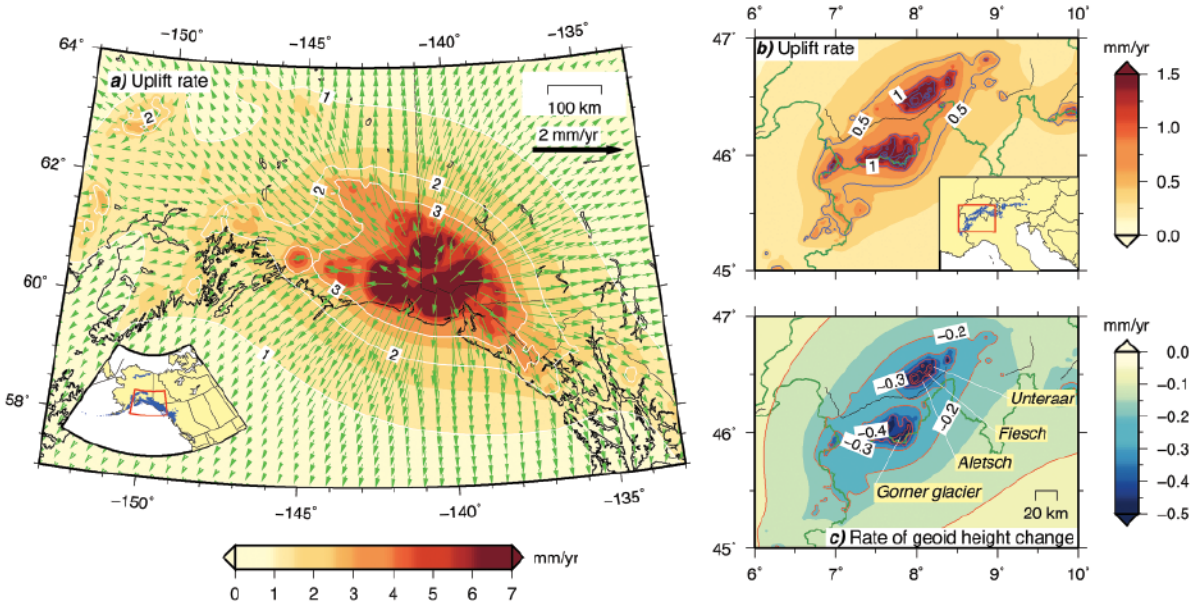

Fig. 1. Simulated vertical and horizontal rates of displacement and rate of geoid height variations (a) in Alaska and western Canada and (b and c) across the Alps between the periods of 1990/1991 and 2010/2011. Simulated rates are from the Regional Elastic Rebound Calculator (REAR) and show deformation changes with unprecedented realism and precision. The rates of mass loss are −43.9 and −2.5 gigatons per year, respectively. The model's resolution corresponds to roughly 1 kilometer on the Earth's surface. Blue areas in the insets show the extent of ice sources employed in these runs. Computing these maps requires only 3.5 minutes on a midrange workstation.

Even though the glacier's mass changed only modestly during the study period, Figure 1c shows that mass loss and surface deformation cause the geoid to subside at a rate of roughly 0.5 millimeter per year across the Alps.

Advantages and Limitations

Because of REAR's simple structure, adding new geodetic variables is straightforward—the user can easily edit the code to produce new outputs such as tilts of the Earth's surface or gravity anomalies induced by the deformations.

However, the software has limitations. For instance, REAR does not model the gravitational attraction between the surface loads and the oceans. Hence, the program is suited for the study of local and regional deformations (on scales up to a few hundreds of kilometers) in response to small surface loads that involve a limited mass variation. Additionally, although nonelastic processes during deformation of low-viscosity crustal layers can be important even for short time scales and especially for large loads [*Spada*, 2008], REAR considers only elastic deformations. Hence, REAR is not suitable for modeling the long-term subsidence caused by sedimentary and volcanic loads, which tend to be nonelastic.

A Fine-Scale View

The level of detail in the maps in Figure 1 would be impossible to capture using computer models that do not account for finely layered mantle and crustal layers or that are not designed to efficiently compute deformation on fine scales. Modern computers with multicore central processing units (CPUs) can efficiently perform REAR calculations to a very high precision, which is necessary to capture deformations down to the kilometer scale.

Details of the map in Figure 1 are captured thanks to the efficient design of REAR and the very high resolution of deformation. We hope that REAR will open up new horizons in crustal deformation studies.

Technical Details

REAR runs on any UNIX environment with a Fortran compiler, including Windows systems running the Cygwin layer. The REAR source code package and a detailed user guide are available from http://bit.ly/REARcalc.

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Author Information

Daniele Melini, Istituto Nazionale di Geofisica e Vulcanologia, Rome, Italy; **Pascal Gegout,** Observatoire Midi-Pyrénées, Toulouse, France; **Matt King,** University of Tasmania, Hobart, Australia; **Ben Marzeion,** University of Innsbruck, Innsbruck, Austria; and **Giorgio Spada,** Università di Urbino, Urbino, Italy; email: giorgio.spada@gmail.com

2015 AGU Union Medal, Award, and Prize Recipients Announced

The Honors and Recognition Committee and the Union selection committees are pleased to announce the recipients of AGU's 2015 Union medals, awards, and prizes.

AGU's vision is to collaboratively advance and communicate science and its power to ensure a sustainable future. Our honorees' achievements help build the foundations on which we will realize that vision.

In an environment that encourages experimentation, innovation, and the free exchange of ideas, these outstanding contributors to the Earth and space sciences thrive. Their work has a profound impact on the ways we live and think.

We thank all who have given their support and commitment to AGU's honors program, including volunteers who serve on the medals, awards, and prizes selection committees that have chosen this year's Union honorees. We also thank the nominators and supporters who made this all possible with their dedicated efforts to recognize their colleagues.

We look forward to celebrating the honorees' breakthrough achievements and exceptional work at the Honors Ceremony and Banquet, to be held on 16 December 2015 at the Fall Meeting in San Francisco.

Please join us in congratulating our esteemed class of 2015 Union honorees listed below.

Medals

William Bowie Medal
Wilfried H. Brutsaert, Cornell University

James B. Macelwane Medal
Paul Cassak, West Virginia University
Bethany L. Ehlmann, California Institute of Technology
Colette L. Heald, Massachusetts Institute of Technology
Matthew G. Jackson, University of California, Santa Barbara
Katharine Maher, Stanford University

John Adam Fleming Medal
Andrew F. Nagy, University of Michigan, Ann Arbor

Maurice Ewing Medal
Russ E. Davis, Scripps Institution of Oceanography

Robert E. Horton Medal
Günter Blöschl, Vienna University of Technology

Harry H. Hess Medal
Claude P. Jaupart, Institut de Physique du Globe de Paris

Roger Revelle Medal
Anne M. Thompson, NASA Goddard Space Flight Center

Inge Lehmann Medal
Peter Olson, Johns Hopkins University

Awards

Ambassador Award
Charles R. Chappell, Vanderbilt University
Lucile Jones, U.S. Geological Survey
Gordon McBean, University of Western Ontario

Edward A. Flinn III Award
Sonia Esperanca and Robin L. Reichlin, National Science Foundation

Charles S. Falkenberg Award
Benjamin L. Preston, Oak Ridge National Laboratory

Athelstan Spilhaus Award
Holly R. Gilbert, NASA Goddard Space Flight Center

International Award
Peter J. Webster, Georgia Institute of Technology

Robert C. Cowen Award for Sustained Achievement in Science Journalism
Andrew Revkin, *The New York Times*

Walter Sullivan Award for Excellence in Science Journalism—Features
Douglas Fox, Freelance Writer

David Perlman Award for Excellence in Science Journalism—News
Sandi Doughton, *The Seattle Times*

Prizes

The Asahiko Taira International Scientific Ocean Drilling Research Prize
Fumio Inagaki, Japan Agency for Marine-Earth Science and Technology

Climate Communications Prize
Richard C. J. Somerville, Scripps Institution of Oceanography

By **Margaret Leinen,** AGU President, and **Sam Mukasa,** Chair, Honors and Recognition Committee; email: agu_unionhonors@agu.org

2015 Class of AGU Fellows Announced

On behalf of the Honors and Recognition Committee and the Union Fellows Committee, we are very pleased to present the 2015 AGU Class of Fellows. Being elected a Union Fellow is a tribute to those AGU members who have made exceptional contributions to Earth and space sciences as valued by their peers and vetted by section and focus group committees. This honor is bestowed on only 0.1% of the membership in any given year.

We thank all who have given their support and commitment to AGU's honors program. These include all the section and focus group Fellows selection committees and the Union Fellows Committee, who gave their valuable time and energy in evaluating and selecting this year's Fellows. We also thank all the nominators and supporters who, through their dedicated efforts to nominate and recognize their colleagues, made all this possible.

We look forward to celebrating their breakthrough achievements and exceptional work at the annual Honors Ceremony and Banquet to be held on 16 December at the 2015 AGU Fall Meeting in San Francisco.

Please join us in congratulating our 2015 AGU Class of Fellows!

Arizona

George E. Gehrels, University of Arizona, Tucson
Jonathan T. Overpeck, University of Arizona, Tucson
Jay Quade, University of Arizona, Tucson
Peter A. Troch, University of Arizona, Tucson

California

Gregory P. Asner, Carnegie Institution for Science, Stanford
Thorsten W. Becker, University of Southern California, Los Angeles
Robert W. Carlson, Jet Propulsion Laboratory, Pasadena
Todd E. Dawson, University of California, Berkeley
Imke de Pater, University of California, Berkeley
Sarah T. Gille, University of California, San Diego, La Jolla
Jennifer W. Harden, California Water Science Center, U.S. Geological Survey, Menlo Park
Glen M. MacDonald, University of California, Los Angeles
Robert Pinkel, University of California, San Diego, La Jolla
Fred F. Pollitz, Earthquake Science Center, U.S. Geological Survey, Menlo Park
Laurence C. Smith, University of California, Los Angeles

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Bette L. Otto-Bliesner, National Center for Atmospheric Research, Boulder
William K. Peterson, University of Colorado Boulder, Boulder
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Allan J. Clarke, Florida State University, Tallahassee

Hawaii

Axel Timmermann, University of Hawaii, Honolulu

Illinois

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Tami C. Bond, University of Illinois at Urbana-Champaign, Urbana
Praveen Kumar, University of Illinois at Urbana-Champaign, Urbana
Yanbin Wang, University of Chicago, Argonne

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Massachusetts

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Minnesota

Michael J. Jackson, University of Minnesota Twin Cities, Minneapolis

Nevada

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New Jersey

Amitava Bhattacharjee, Princeton University, Princeton

New York

Geoffrey A. Abers, Cornell University, Ithaca
Suzanne M. Carbotte, Lamont-Doherty Earth Observatory, Palisades
Peter A. Fox, Rensselaer Polytechnic Institute, Troy
Cynthia Rosenzweig, NASA Goddard Institute for Space Studies, New York
Larry D. Travis, NASA Goddard Institute for Space Studies, New York

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Hans W. Paerl, University of North Carolina at Chapel Hill, Morehead City

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Michael G. Bevis, Ohio State University, Columbus

Oregon

Roger M. Samelson, Oregon State University, Corvallis

Pennsylvania

Charles J. Ammon, Pennsylvania State University, University Park

Texas

Ping Yang, Texas A&M University, College Station

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Alex B. Guenther, Pacific Northwest National Laboratory, Richland

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Martin Visbeck, GEOMAR Helmholtz Centre for Ocean Research Kiel, Kiel, Germany
Guoxiong Wu, Chinese Academy of Sciences, Beijing, China

By **Margaret Leinen,** AGU President, and **Christina Ravelo,** Chair, Union Fellows Committee; email: agu_unionhonors@agu.org

2015 AGU Section and Focus Group Awardees and Named Lecturers

On behalf of AGU's leaders and staff, we give our heartfelt congratulations to all of this year's section and focus group awardees and named lecturers.

Listed below are the scientists, in various stages of their careers, who have been selected by AGU sections and focus groups to receive awards in 2015. Also listed are those individuals chosen to present lectures under the annual Bowie Lecture Series as well as the Section and Focus Group Named Lecture Series.

The Bowie Lecture was inaugurated in 1989 to commemorate the fiftieth presentation of the William Bowie Medal, which is named for AGU's first president and is the highest honor given by AGU. Bowie lecturers in the list below are denoted by asterisks. Named lecturers are designated by sections and focus groups to honor distinguished scientists in their respective fields of science.

We thank all sections and focus groups for giving these recognitions to their well-deserving colleagues. These awardees/lecture recipients represent some of the most innovative minds in their fields. We recognize their continuing meritorious work and service toward the advancement and promotion of discovery in Earth and space science for the benefit of humanity.

We look forward to recognizing their achievements at the 2015 AGU Fall Meeting, to be held 14–18 December in San Francisco, Calif.

Atmospheric and Space Electricity Focus Group

Franklin Lecture
Paul Krehbiel, New Mexico Institute of Mining and Technology

Atmospheric Sciences Section

Ascent Award
Jiwen Fan, Pacific Northwest National Laboratory
Andrew Gettelman, University Corporation for Atmospheric Research
Allen Robinson, Carnegie Mellon University
Allison Steiner, University of Michigan

James R. Holton Junior Scientist Award
Chunsong Lu, Nanjing University of Information Science and Technology

Yoram J. Kaufman Unselfish Cooperation in Research Award
Brent Holben, NASA
Christos Zerefos, University of Athens

*Bjerknes Lecture**
Kerry Emanuel, Massachusetts Institute of Technology

*Charney Lecture**
Meinrat Andreae, Max Planck Institute for Chemistry

Biogeosciences Section

Sulzman Award for Excellence in Education and Mentoring
Ruth Varner, University of New Hampshire

William S. and Carelyn Y. Reeburgh Lecture
Gary King, Louisiana State University

Cryosphere Focus Group

Cryosphere Early Career Award
Sarah Kapnick, National Oceanic and Atmospheric Administration

Nye Lecture
Eric Rignot, University of California, Irvine

Earth and Planetary Surface Processes Focus Group

G. K. Gilbert Award in Surface Processes
Robert Anderson, University of Colorado, Boulder

Luna B. Leopold Award
Vamsi Ganti, California Institute of Technology

Sharp Lecture
Vamsi Ganti, California Institute of Technology

Earth and Space Science Informatics Focus Group

Leptoukh Lecture
Dawn Wright, Environmental Systems Research Institute

Geodesy Section

Geodesy Section Award
Matt Pritchard, Cornell University

Ivan I. Mueller Award for Service and Leadership
Charles Meertens, UNAVCO

*William Bowie Lecture**
Daniel Dzurisin, Cascades Volcano Observatory, U.S. Geological Survey

Geomagnetism and Paleomagnetism Section

William Gilbert Award
Michael Jackson, University of Minnesota

*Bullard Lecture**
Steven Constable, Scripps Institution of Oceanography

Global Environmental Change Focus Group

Schneider Lecture
Donald Wuebbles, University of Illinois at Urbana-Champaign

Tyndall Lecture
Julie Brigham-Grette, University of Massachusetts Amherst

Hydrology Section

Early Career Hydrologic Science Award
Tom Gleeson, University of Victoria

Horton Research Grant
Laura Stevens, Massachusetts Institute of Technology
Emily Voytek, Colorado School of Mines
Adam Wlostowski, Colorado State University

Hydrologic Sciences Award
Dara Entekhabi, Massachusetts Institute of Technology

*Langbein Lecture**
Tissa Illangasekare, Colorado School of Mines

Mineral and Rock Physics Focus Group

Mineral and Rock Physics Early Career Award
Nicolas Brantut, University College London

Mineral and Rock Physics Graduate Research Award
Yun-Yuan Chang, Academica Sinica
Zhang Dongzhou, California Institute of Technology

Natural Hazards Focus Group

Natural Hazards Focus Group Award for Graduate Research
Cheng Linyin, University of California, Irvine

Gilbert F. White Lecture
Susan Cutter, University of South Carolina

Nonlinear Geophysics Focus Group

Donald L. Turcotte Award
Jezabel Curbelo, Universidad Autonoma de Madrid
Behzad Ghanbarian-Alavijeh, University of Texas at Austin

Space Weather and Nonlinear Waves and Processes Prize
Gurbax Lakhina, Indian Institute of Geomagnetism

Lorenz Lecture
Shaun Lovejoy, McGill University

Ocean Sciences Section

Ocean Sciences Early Career Award
Angel White, Oregon State University

Ocean Sciences Award
Don Rice, National Science Foundation

Carson Lecture
Mary Jane Perry, University of Maine

Sverdrup Lecture
Fiamma Straneo, Woods Hole Oceanographic Institution

Paleoceanography and Paleoclimatology Focus Group

Dansgaard Award
Adina Paytan, University of California, Santa Cruz

Planetary Sciences Section

Ronald Greeley Early Career Award in Planetary Science
Ian Garrick-Bethell, University of California, Santa Cruz

Whipple Award and Lecture
Alfred McEwen, University of Arizona

Sagan Lecture
John Asher Johnson, Harvard University

*Shoemaker Lecture**
William Bottke, Southwest Research Institute

Seismology Section

Keiiti Aki Young Scientist Award
Sanne Cottar, University of Cambridge

*Gutenberg Lecture**
Kazushige Obara, University of Tokyo

Space Physics and Aeronomy Section

Basu United States Early Career Award
Timothy Duly, University of Illinois at Urbana

Fred L. Scarf Award
Majd Matta, Boston University

Space Physics and Aeronomy Richard Carrington Education and Public Outreach Award
Charles Chappell, Vanderbilt University

Sunanda and Santimay Basu Early Career Award in Sun-Earth Systems Science
Chaowei Jiang, Chinese Academy of Sciences

Eugene Parker Lecture
Phil Scherrer, Stanford University

*James Van Allen Lecture**
Michelle Thomsen, Planetary Institute Tucson

Study of the Earth's Deep Interior Focus Group

Study of the Earth's Deep Interior Graduate Research Award
Matt Weller, Rice University

Tectonophysics Section

Jason Morgan Early Career Award
Lijun Liu, University of Illinois at Urbana-Champaign

*Birch Lecture**
Kelin Wang, Geological Survey of Canada

Volcanology, Geochemistry and Petrology Section

Hisashi Kuno Award
Chris Huber, Georgia Institute of Technology

Norman L. Bowen Award and Lecture
Tom Sisson, U.S. Geological Survey

*Daly Lecture**
Katharine Cashman, University of Bristol

Joint Award: Geodesy, Seismology, and Tectonophysics Sections

Paul G. Silver Award
Robert Smith, University of Utah

Joint Lecture: Paleoceanography and Paleoclimatology and Ocean Sciences

Emiliani Lecture
Alan Mix, Oregon State University

By **Eric Davidson,** AGU President-elect and Chair, AGU Council, and **Sam Mukasa,** 2015–2016 Chair, Honors and Recognition Committee

Member Comment Period Open for AGU Bylaws Amendments

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A member comment period is now open for two minor amendments to the AGU bylaws. The changes relate to section and focus group voting and development board leadership. The comment period will end on 6 September 2015.

Voting Restriction Lifted

AGU encourages members to join as many sections and focus groups as desired. The first amendment removes the voting restriction for members belonging to more than three sections and focus groups.

Almost 25% of AGU members belong to four or more sections and focus groups, and this restriction was creating confusion during elections. It also seemed inconsistent with AGU's strategic plan and growing commitment to interdisciplinary and transdisciplinary science.

In December 2013, the Council determined that members should be allowed to vote for officers in any or all sections and focus groups to which they belong. It voted to remove the voting restriction, and the change was implemented in the 2014 AGU election. This is a cleanup of the bylaw's language to make it consistent with the already implemented voting change.

New Role for AGU Past Past President

The second amendment would change which AGU president serves as vice chair of the Development Board. The bylaws specify that AGU's president-elect will serve in this position; the amendment recommends that the AGU past past president serve as vice chair instead.

AGU's president-elect already has significant responsibilities and time commitments serving as the Council chair, Council Leadership Team chair, Board vice chair, and an Executive Committee member. The past past president is well positioned to provide leadership to the Development Board, having just rotated off the AGU Board.

AGU members are asked to review the amendments on the AGU Bylaws web page (http://bit.ly/bylawspage) and to respond in one of these three ways listed on the Member Comment Period web page (http://bit.ly/commperiod):

1. No Comment: The proposed changes look OK to me.
2. Abstain from commenting.
3. Submit comments.

If you have any questions, please contact Cheryl Enderlein.

By **Cheryl Enderlein**, Assistant Director of Leadership, AGU; email: cenderlein@agu.org

Share Your Science with Today's Teachers, Tomorrow's Scientists

Are you interested in fostering the next generation of Earth and space scientists? Two opportunities to share your science with children, parents, and teachers are coming up at the 2015 AGU Fall Meeting. One is a Sunday afternoon spread of hands-on, kid-oriented science exhibits and activities, called Exploration Station. The other is a weekday training seminar, known as the Geophysical Information for Teachers (GIFT) Workshop. In this workshop, scientists like yourself share the ins and outs of your field with a classroom full of talented K–12 educators.

Both offer great opportunities to get your research out there and to hone your communication skills. These events are part of AGU's Sharing Science program (see http://sharingscience.agu.org/), which helps scientists engage a broad audience in Earth and space science. By participating, you'll learn how to better present technical material in a way that the general public can understand, and you'll help close the gap between what you do as a scientist and the public's understanding of science. What's more, these programs are just plain fun!

Gary Wagner

A Cub Scout investigates rocks at the Exploration Station during the 2014 Fall Meeting.

Exploration Station Draws Crowds

Do you like working with children? Create an exhibit and help involve kids in hands-on activities at Exploration Station. Open to the public, this event attracts local San Francisco families and teachers, as well as Fall Meeting attendees and their families. Visitors enjoy giveaways, demonstrations, and immersive activities. Exploration Station attendance more than doubled last year to nearly 1000 visitors; we expect this year to be even better.

Past Exploration Stations featured stomp rockets, iPad apps, and a planetarium. Last year, the event also included, for the first time, a set of activities meant to appeal particularly to Boy Scouts and Girl Scouts. They had a great time working with scientists to complete merit badge requirements. This year, we will again include activities geared to scouts.

To become an exhibitor, read our FAQs (http://bit.ly/ES_FAQs) and register by 21 August at http://bit.ly/ES_register. Exploration Station will be held from 1:00 to 5:00 p.m. on Sunday, 13 December.

> You'll help close the gap between what you do as a scientist and the public's understanding of science.

Enduring Impact

If you want to have more clout in K–12 science classrooms, pair with an expert educator at the 2015 GIFT Workshop and share your knowledge there.

Selected scientists will present classroom activities and resources that bring students a step closer to the cutting edge of scientific research. The impact doesn't stop at the workshop: Attendees range from public school teachers to informal educators, so information will disseminate through multiple avenues. Materials will remain online afterward in the form of Live Education Activity Resource Network (LEARN) videos. Check out videos from past workshops on the LEARN site (see http://bit.ly/AGU_LEARN), such as one about making predictions about Yellowstone National Park volcanoes and another about a game exploring pollination.

If you have ideas to share and would like to present, please submit an application by 31 August (see http://bit.ly/GIFT_apply). The 2015 GIFT Workshop will be held from 7:30 a.m. to 3:30 p.m. on Monday, 14 December, and Tuesday, 15 December.

New this year, each team of presenters receives one free full-week registration to Fall Meeting, to be used by one member of the presenting team.

Newcomers Welcome

These events grow larger each year, and AGU is always happy to have new scientists get involved and share their passion for Earth and space science. The interaction of scientists with Exploration Station and GIFT Workshop attendees empowers teachers and students. It also strengthens the impact of science professionals. As one 2013 GIFT Workshop teacher put it, the AGU Fall Meeting provided an "excellent opportunity for teachers to connect with research scientists." For this educator, the experience made the Fall Meeting that year "second to none."

By **Victoria Anania,** Education Intern, AGU; email: vanania@agu.org

AGU HONORS

The Honors and Recognition Committee and the Union Medals, Fellows, Awards, and Prizes committees are very pleased to present the 2015 AGU Union Honorees

Medals

William Bowie Medal
Wilfried H. Brutsaert, Cornell University

James B. Macelwane Medal
Paul Cassak, West Virginia University
Bethany L. Ehlmann, California Institute of Technology
Colette L. Heald, Massachusetts Institute of Technology
Matthew G. Jackson, University of California, Santa Barbara
Katharine Maher, Stanford University

John Adam Fleming Medal
Andrew F. Nagy, University of Michigan

Maurice Ewing Medal
Russ E. Davis, Scripps Institution of Oceanography

Robert E. Horton Medal
Günter Blöschl, Vienna University of Technology

Harry H. Hess Medal
Claude P. Jaupart, Institut de Physique du Globe de Paris

Roger Revelle Medal
Anne M. Thompson, NASA Goddard Space Flight Center

Inge Lehmann Medal
Peter Olson, Johns Hopkins University

Fellows

Geoffrey A. Abers, Cornell University
Charles J. Ammon, Pennsylvania State University
Gregory P. Asner, Carnegie Institution for Science*
Lawrence E. Band, University of North Carolina at Chapel Hill
Paul D. Bates, University of Bristol
Thorsten W. Becker, University of Southern California
James Best, University of Illinois at Urbana-Champaign
Michael G. Bevis, Ohio State University
Amitava Bhattacharjee, Princeton University
Tami C. Bond, University of Illinois at Urbana-Champaign
Christopher S. Bretherton, University of Washington*
Suzanne M. Carbotte, Lamont-Doherty Earth Observatory
Robert W. Carlson, Jet Propulsion Laboratory
Jeffrey Chanton, Florida State University
Michael A. Church, University of British Columbia
Olaf A. Cirpka, University of Tübingen
Allan J. Clarke, Florida State University
Todd E. Dawson, University of California, Berkeley
Mark J. Dekkers, Utrecht University
Imke de Pater, University of California, Berkeley
Georgia Destouni, Stockholm University
John W. Farrington, Woods Hole Oceanographic Institution
Peter A. Fox, Rensselaer Polytechnic Institute*
George E. Gehrels, University of Arizona

*Corrected from 1 August print issue of *Eos* magazine

Sarah T. Gille, University of California, San Diego
Alex B. Guenther, Pacific Northwest National Laboratory
Jennifer W. Harden, U.S. Geological Survey*
Michael J. Jackson, University of Minnesota, Twin Cities
Jose-Luis Jimenez, University of Colorado Boulder
Ian R. Joughin, University of Washington
Praveen Kumar, University of Illinois at Urbana-Champaign
Glen M. MacDonald, University of California, Los Angeles
Hugh S. O'Neill, Australian National University*
Bette L. Otto-Bliesner, National Center for Atmospheric Research
Jonathan T. Overpeck, University of Arizona
Hans W. Paerl, University of North Carolina at Chapel Hill
William K. Peterson, University of Colorado Boulder
Robert Pinkel, University of California, San Diego
Fred F. Pollitz, U.S. Geological Survey, Earthquake Science Center*
Jay Quade, University of Arizona
William J. Randel, National Center for Atmospheric Research*
Philip J. Rasch, Pacific Northwest National Laboratory
Lorraine A. Remer, University of Maryland, Baltimore County*
Michael L. Roderick, Australian National University*
Daniel Rosenfeld, Hebrew University of Jerusalem
Cynthia Rosenzweig, NASA Goddard Institute for Space Studies
Roger M. Samelson, Oregon State University
Martha K. Savage, Victoria University of Wellington*
Barbara Sherwood Lollar, University of Toronto
Laurence C. Smith, University of California, Los Angeles
Michael J. Thompson, University Corporation for Atmospheric Research
Axel Timmermann, University of Hawaii*
Larry D. Travis, NASA Goddard Institute for Space Studies*
Peter A. Troch, University of Arizona
Scott W. Tyler, University of Nevada, Reno
Jean-Pierre Vilotte, Institut de Physique du Globe de Paris
Martin Visbeck, GEOMAR Helmholtz Centre for Ocean Research Kiel
Yanbin Wang, University of Chicago
Guoxiong Wu, Institute of Atmospheric Physics, Chinese Academy of Sciences*
Ping Yang, Texas A&M University

Awards

Ambassador Award
Charles R. Chappell, Vanderbilt University
Lucile Jones, U.S. Geological Survey*
Gordon McBean, University of Western Ontario

Edward A. Flinn III Award
Sonia Esperanca and Robin L. Reichlin, National Science Foundation

Charles S. Falkenberg Award
Benjamin L. Preston, Oak Ridge National Laboratory

Athelstan Spilhaus Award
Holly R. Gilbert, NASA Goddard Space Flight Center*

International Award
Peter J. Webster, Georgia Institute of Technology*

Robert C. Cowen Award for Sustained Achievement in Science Journalism
Andrew Revkin, *The New York Times*

Walter Sullivan Award for Excellence in Science Journalism–Features
Douglas Fox, Freelance Writer

David Perlman Award for Excellence in Science Journalism–News
Sandi Doughton, *The Seattle Times*

Prizes

The Asahiko Taira International Scientific Ocean Drilling Research Prize
Fumio Inagaki, Japan Agency for Marine-Earth Science and Technology

Climate Communications Prize
Richard C. J. Somerville, Scripps Institution of Oceanography

honors.agu.org

Underwater Robot Tracked Ocean Sediment During Hurricane Sandy

Nilsen Strandskov/Rutgers University

A Teledyne Webb autonomous underwater glider RU23 belonging to Rutgers University deployed off the New Jersey coastline in 2012.

In October 2012, Hurricane Sandy struck the northeastern United States around New Jersey and devastated a number of large metropolitan areas, including New York City. For all the destruction and chaos it wrought, the storm also allowed researchers to closely monitor a host of environmental and physical phenomena associated with a storm of such magnitude.

Miles et al. report observations of ocean sediment movement off New Jersey's coast, caused by the storm. Data from an ocean glider equipped with a host of scientific instrumentation and deployed ahead of the storm allowed researchers not only to see how sediment was being redistributed by the hurricane as the storm unfolded but also to compare their real-life observations with forecasts from mathematical models.

The glider used optical and acoustic backscatter—techniques similar to radar in which sound or light is bounced off of surroundings and analyzed upon return—to survey the water for sediment particles of two different sizes (0.4 and 0.1 millimeter) commonly used in models. It observed that both particle sizes got completely suspended in the water column during the 24-hour period of peak storm intensity.

In addition to confirming the models' predictions, the finding indicates that perhaps unsurprisingly, Hurricane Sandy was seriously stirring up the ocean floor along her path. Certainly, this leads to erosion in some areas, but it also increases sediment deposition in others.

The researchers conclude that after the hurricane made landfall, its energy dipped below the threshold necessary to keep the sediment particles suspended in the water column. But where did all that swirling debris land?

According to the model predictions, Sandy dropped about 3 centimeters of sediment across the continental shelf just north of the Delaware Bay. The team suggests that hurricanes play an important role in redistributing ocean sediment and that gliders can play a valuable role in tracking a storm's effect on local ecosystems. (*Journal of Geophysical Research: Oceans*, doi:10.1002/2014JC010474, 2015) **—David Shultz, Freelance Writer**

Urbanization Threatens Drought-Reducing Clouds in California

Subtropical stratus clouds—low-lying, relatively thin clouds often referred to as "aboveground fog"—regulate coastal, and even global, climate. Small decreases in the occurrence of these near-surface clouds would drive up temperatures and exacerbate drought conditions, but climate models are not consistent in predicting the impact of stratus clouds. Looking back at historical records to analyze past cloud cover and temperature trends could give scientists important insights into how the clouds may be influencing climate conditions.

Williams et al. pored through 67 years' worth of hourly observations of fog, stratus cloud frequency, and stratus cloud base height taken from 24 airfields across coastal southern California, clustered in four areas: Los Angeles, San Diego, Santa Barbara, and two islands west of Los Angeles. The researchers found that between 1948 and 2014, stratus frequency decreased by 23% in the Los Angeles area. Declines were nearly as common in San Diego but did not occur in Santa Barbara or the islands.

Even larger trends were observed with fog. Los Angeles saw a 63% reduction in fog frequency, whereas San Diego experienced less severe fog reductions, and fog frequency remained stable in Santa Barbara and increased over the islands. These trends were most pronounced in the early morning, when stratus clouds and fog are most common.

The trends match changes observed in cloud base heights. Base heights have risen in Los Angeles by an average of 12.7 meters per decade. These heights increased in San Diego to a lesser extent but remained the same over Santa Barbara, whereas they have actually fallen over the islands.

Park Williams

Marine stratus clouds thinly scattered over Marina Del Rey in Los Angeles in August 2014.

The historical cloud records are consistent with an urban heat island effect: Increases in nighttime and early morning warming prevent water vapor from condensing out of the air into clouds near the surface of the Earth. Higher temperatures essentially lift the altitude of condensation and cloud base height, thereby reducing fog frequency. The researchers found that, in general, the more urbanized areas in the study had larger increases in cloud base height and larger decreases in the frequency of fog and low stratus clouds.

This pattern is troubling because fewer daytime clouds, and resultant decreases in shading and water deposition to ecosystems, can cause warming and drought. Warming further reduces fog and stratus cloud formation. This positive feedback loop can lead to increases in water and energy demand, wildfire risk, and adverse public health consequences. However, from the perspective of transportation safety and tourism, these changes in cloud base height could have positive effects. (*Geophysical Research Letters,* doi:10.1002/2014GL063266, 2015)

—Chris Palmer, Freelance Writer

Gaseous Planets May Have Huge Luminous Rings Caused by Lightning

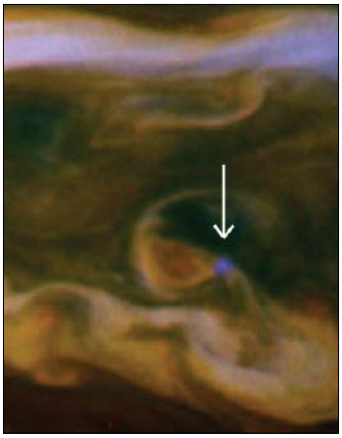
Jupiter and Saturn—and other gas giant planets like them in alien solar systems—may have a strange phenomenon related to lightning in their upper atmospheres known as "elves."

This phenomenon was first discovered in the upper reaches of Earth's atmosphere in the early 1990s. Unlike conventional lightning, which strikes from cloud to cloud or cloud to ground, elves appear high above thunderclouds at the edge of space as an enormous, expanding red ring. First recorded from the space shuttle *Discovery,* the glow can reach 500 kilometers in diameter in 1 millisecond.

Elves occur when lightning in a thunderstorm triggers a disturbance in the electric and magnetic fields called an electromagnetic pulse (EMP). This pulse reaches into the upper layers of the Earth's atmosphere and expands outward, jolting electrons and exciting nitrogen molecules, which emit a faint red glow. This light also provides the grounds for the phenomenon's whimsical acronym: Emissions of Light and Very low frequency perturbations due to Electromagnetic pulse Sources.

Luque et al. used simulations to explore whether elves can also occur on Jupiter and Saturn, where conventional lightning has previously been spotted. They modeled EMPs in the atmospheres of those gas giant planets and found that the effects were much stronger than on Earth, creating a layer of ionization high above the storms. The resulting elve was enormous—expanding to a diameter of nearly 4000 kilometers. Elves are especially bright at Saturn, and NASA's Cassini orbiter is almost capable of imaging them, the authors' calculations show. They also suspect that elves probably occur on similar planets—cold gas giants far from their host stars—in other solar systems. (*Journal of Geophysical Research: Space Physics,* doi:10.1002/2014JA020457, 2014)

—Mark Zastrow, Freelance Writer



NASA/JPL-Caltech/Space Science Institute

Lightning on Saturn, seen here as a purple dot in this false-color image, may generate glowing rings called elves that expand through the planet's upper atmosphere.

AGU's Career Center is the main resource for recruitment advertising.

All Positions Available and additional job postings can be viewed at **https://eos.org/jobs-support.**

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* Print-only recruitment ads will only be allowed for those whose requirements include that positions must be advertised in a printed/paper medium.

Atmospheric Sciences

Postdoctoral Scientist in "Multi-Decadal Internal Climate Variability and Its Role in Climate Change"

The Atmospheric and Oceanic Sciences Program at Princeton University, in cooperation with NOAA's Geophysical Fluid Dynamics Laboratory (GFDL), seeks a postdoctoral scientist for research related to multi-decadal internal (natural) climate variability and its potential role in explaining observed climate changes. A key focus is to improve understanding of the role of low frequency internal climate variability in the current "hiatus" in global warming, as well as previous hiatus and accelerated-warming periods during the 20th century. Such understanding plays an important role in the detection and attribution of observed climate changes. The research will use various approaches to understand the physical mechanisms causing the observed decadal changes including quantification of contributions from both internal climate variability and responses of the climate system to various natural and anthropogenic forcing agents (e.g., greenhouse gases, aerosols, and volcanic eruptions). The research will make extensive use of both observations and a variety of modeling tools. The selected candidate will have a Ph.D. and one or more of the following attributes: (a) a strong background in climate/ocean dynamics or coupled air–sea interactions, (b) experience conducting and analyzing coupled climate model experiments, and (c) strong diagnostic skills in analyzing simulated and observed data sets.

This is a two-year position (subject to renewal after the first year contingent upon satisfactory performance and funding availability) based at GFDL/NOAA in Princeton, New Jersey. Complete applications, including a CV, publication list, names of 3 references for letters of recommendation, and a one-to-two page statement of research interests should be submitted. Review of applications will begin as soon as they are received and continue until the position is filled. Applicants should apply online to http://jobs.princeton.edu, Requisition #1500509. For additional information on the position, please contact Rong Zhang (Rong.Zhang@noaa.gov) or Tom Knutson (Tom.Knutson@noaa.gov). This position is subject to the University's background check policy.

Princeton University is an equal opportunity employer and all qualified applicants will receive consideration for employment without regard to race, color, religion, sex, sexual orientation, gender identity, disability status, protected veteran status, or any other characteristic protected by law.

EMPLOYMENT ANNOUNCEMENT

Researcher Position in Climate and Atmospheric Chemistry

Research Center for Environmental Changes
Academia Sinica
TAIPEI, TAIWAN

The Research Center for Environmental Changes invites applications at the Assistant, Associate and Full Research Fellow levels in the following fields:

1) Diagnostics and modeling of climate variability and change, and climate model development;
2) Atmospheric chemistry, particularly relevant to the changes in regional atmospheric composition and air quality.

One position for each field beginning in 2016 is available. Applicants are expected to have a doctoral degree in related fields by start of the appointment. Further information about the Research Center for Environmental Changes and related research can be found at http://www.rcec.sinica.edu.tw/.

Applicants should send their curriculum vitae, research plan and the names of three referees, before October 15, 2015, to:

Dr. Huang-Hsiung Hsu, Chair
Researcher Search Committee
Research Center for Environmental Changes,
Academia Sinica,
128, Academia Road, Section 2
Taipei 115, Taiwan
Tel: +886-2-2652-5173
Fax: +886-2-2783-3584
E-mail: hhhsu@gate.sinica.edu.tw

, and also a copy to Dr. Charles C.-K. Chou (ckchou@gate.sinica.edu.tw).

Both regular and electronic mails are acceptable. Upon receipt of the application, an acknowledgement email will be sent to the applicant within a week. Applicants who do not receive the acknowledgement email please contact the Chair of the Researcher Search Committee via email or telephone for confirmation.

Hydrology

Tenure-Track Assistant Professor Position GROUNDWATER HYDROLOGIST University of Wyoming

The Department of Civil and Architectural Engineering at the University of Wyoming invites applications for a tenure-track faculty position in Groundwater Hydrology at the Assistant Professor level. We seek a candidate with the interest and ability to develop and sustain a nationally competitive research program. The successful candidate must hold an earned doctoral degree in Civil Engineering or in a closely related discipline by the position start date. Registration as a professional engineer or professional hydrologist are desirable but not required. The successful candidate must be able to teach courses in fluid mechanics, hydraulics, hydrology, and water resources engineering. Also, the successful candidate must have the demonstrated ability to develop an externally funded research program in groundwater hydrology.

This position will become part of a major research thrust in water resources at the University of Wyoming. Groundwater resources are of immense importance to societal and ecological needs. Approximately half of Wyoming water resources are from groundwater, and subsurface resources provide critical water to agriculture, oil and gas development, and municipalities. There are tremendous research challenges in groundwater resulting from changing climate signals and human population patterns, and emerging techniques provide outstanding opportunities for groundwater hydrologists to better quantify the fate and transport of water in a changing west. We seek a groundwater hydrologist with experience in laboratory and field approaches for describing complex subsurface processes. Areas of specific interest include, but are not limited to, surface-groundwater interaction, unsaturated flow and contaminant transport.

As a member of the faculty of the Department of Civil and Architectural Engineering, the successful candidate will integrate his or her research with the goals of the new Wyoming Center for Environmental Hydrology and Geophysics (http://www.uwyo.edu/epscor/wycehg/) and provide academic support to the PhD program in Water Resources, Environmental Science and Engineering (http://www.uwyo.edu/wrese/).

UW faculty have access to world-class computational resources as described at: https://arcc.uwyo.edu/. The department is supported by 22

tenured or tenure-track faculty and offers ABET-accredited baccalaureate programs in both civil engineering and architectural engineering to approximately 300 undergraduate students. The department also offers graduate programs at the Masters and PhD levels to roughly 60 graduate students.

Laramie is a picturesque and friendly town offering a reasonable cost of living, good K-12 public schools and easy access to outdoor activities in the Rocky Mountain region. Additional information on the Department, College, and Laramie is available at: http://www.uwyo.edu/civil, http://ceas.uwyo.edu and http://www.laramie.org.

Applications must include: 1) a letter of application, 2) a curriculum vitae including a list of publications, 3) a statement of research interests, 4) a statement of teaching interests, and 5) contact information for at least three references. Do not include supplemental information such as off-prints of papers, reference letters, or transcripts. Review of applications will begin 15 September 2015 and continue until the position is filled. The preferred start date for the position is January 2016. Submit applications in a single PDF file to: water_search@uwyo.edu.

The University of Wyoming is an Equal Employment Opportunity/Affirmative Action employer. All qualified applicants will receive consideration for employment without regard to race, color, religion, sex, national origin, disability or protected veteran status or any other characteristic protected by law and University policy. Please see: http://www.uwyo.edu/diversity/fairness. We conduct background investigations for all final candidates being considered for employment. Offers of employment are contingent upon the completion of the background check.

Ocean Sciences

Assistant/Associate Professor with focus on remote sensing and ocean circulation.

The College of Earth, Ocean, and Atmospheric Sciences at Oregon State University located in Corvallis, Oregon invites applications full-time, 12 month tenure-track position.

We seek a colleague to develop and maintain a vigorous, externally funded research program in ocean remote sensing. This position will specialize in applying, developing and improving satellite remote sensing capabilities to study mesoscale and large-scale ocean circulation, may develop transformative observational capabilities in oceanic physics. This position will: complement existing CEOAS research programs in coastal and large-scale ocean circulation, ocean-atmosphere interactions and climate variability and change; participate in undergraduate and graduate teaching program by teaching courses in physical oceanography and ocean remote sensing, and advise/mentor students and/or postdocs is expected. Requires: Ph.D. ocean sciences or other related physical discipline by the start of employment; scholarly potential demonstrated by a record of peer-reviewed publications and a clearly defined research agenda; potential for establishing a funded research program; potential for teaching excellence, student success, mentoring students/postdocs. For CEOAS information see: http://ceoas.oregonstate.edu To apply go to: http://oregonstate.edu/jobs posting #0015241. For full consideration apply by 09/14/2015. Closing date: 10/14/2015.

Interdisciplinary/Other

Assistant Professor Mineralogy/Petrology/Earth Materials West Virginia University

The Department of Geology and Geography at West Virginia University seeks to hire a tenure track Assistant Professor specializing in Earth Materials. This could include expertise in Igneous, Metamorphic, Sedimentary or Organic Petrology, Mineralogy, Geomicrobiology or related fields. The successful candidate will have the opportunity to develop a vigorous externally-funded research program. The new hire will also teach core undergraduate classes covering the origins of rocks and minerals, as well as graduate courses in the area of his/her expertise.

Requirements include: a Ph.D. in Earth Science by the start date, evidence of potential to establish a strong externally-funded research program, ability to publish in peer-review journals, and a commitment to teaching excellence at the undergraduate and graduate levels.

Qualified applicants should: (1) submit a single PDF file including a statement of research interests, a statement of teaching philosophy, and a curriculum vitae; (2) submit PDF files of up to 3 publications; and (3) arrange for three letters of reference to be sent. All documents should go to earthmaterials@mail.wvu.edu.

Review of applications will begin Sept. 30, 2015 and continue until the position is filled. The anticipated start date is August of 2016.

For additional information, please see http://pages.geo.wvu.edu/earthmaterials or contact the search chair: Jaime Toro at jtoro@wvu.edu or (304) 293 9817.

West Virginia University is an EEO/Affirmative Action Employer and welcomes applications from all qualified individuals, including minorities, females, individuals with disabilities, and veterans.

Faculty Position in Geology or Geophysics at the University of Michigan

The Department of Earth and Environmental Sciences at the University of Michigan anticipates an opening for a tenure-track assistant professor in the areas of geology or geophysics for a university-year appointment starting

September 1, 2016. The Department intends to pursue additional hires in this direction in future years, and we are particularly interested in candidates whose strengths will complement existing research programs within the Department.

Geology: We encourage applications from candidates whose research interests encompass the origin, evolution, or dynamics of the continents. The successful candidate will develop a strong field-based research program, complemented by expertise in modern analytical techniques or in numerical or analogue modeling. Candidates with an interest in understanding continental evolution in deep geologic time are particularly encouraged to apply.

Geophysics: We encourage applications from candidates who will develop an observationally based research program using geophysical methods (e.g. seismology, geodesy, or potential fields) to study the Earth at the crustal or continental scale. We are particularly interested in those applicants whose work is relevant to societal concerns including natural hazards, such as earthquakes, volcanism, and associated hazards, or environmental change to the hydrosphere or cryosphere.

The successful candidate is expected to establish an independent research program and contribute to both undergraduate and graduate teaching. Applicants must have a Ph.D. at the time of appointment, and should submit a CV, statement of current and future research plans, statement of teaching philosophy and experience, evidence of teaching excellence (if any), and names and contact information of at least four persons who can provide letters of recommendation.

Information about the Department and instructions for submitting an application can be found at www.lsa.umich.edu/earth.

To apply please go to http://www.earth.lsa.umich.edu/facultysearch/newapplicant, complete the online form and upload the required application documents as a single PDF file. If you have any questions or comments, please send an email message to Michigan-Earth-Search@umich.edu.

The application deadline is September 15, 2015 for full consideration, but applications will continue to be reviewed until the position is filled. Women and minorities are encouraged to apply. The University of Michigan is supportive of the needs of dual career couples and is an equal opportunity/affirmative action employer.

ASSISTANT COOPERATIVE EXTENSION SPECIALIST Integrated Urban Water Management University of California, Riverside

The College of Natural and Agricultural Sciences at the University of California, Riverside invites applications for an Assistant Cooperative Exten-

sion (CE) Specialist position in integrated urban water management. The position has a 75% Cooperative Extension and a 25% Organized Research appointment in the Agricultural Experiment Station (http://cnas.ucr.edu/about/aes/) and will be located in the Department of Environmental Sciences, University of California at Riverside. The successful candidate will provide leadership for developing an applied research and outreach education program focusing on urban water conservation and irrigation management in cooperation with a statewide network of UC ANR specialists, advisors, and on campus academics working in water resources, environmental horticulture, and related areas. Clientele include UCANR CE advisors; state, regional and local water resource regulators and managers; other public and non-profit agencies; private industries, and domestic water users. The successful candidate is expected to have expertise in the development of sustainable strategies for increasing urban water use efficiency for large commercial and publicly-maintained irrigated landscapes as well as urban landscapes; management practices for reducing urban runoff and runoff water capture and reuse; rain harvesting to reduce pollutant loads to waterways; and safe application of greywater and reclaimed wastewater reuse. Developing strategies for long-range planning in the area of keeping plants alive under continued drought and water restrictions is an important aspect of this position. A Ph.D. in Water Resources and Management, Water Resource Engineering, Soil and Water Science, Natural Resources, Environment Sciences or related field. The ability to conduct innovative urban water management and conservation research and education programs and measure their impact is required. Excellent communication and interpersonal skills are essential. Applications will be reviewed for full consideration commencing September 1, 2015, the position will remain open until filled. Applications must include a vita, statements of research and teaching interests, and at least 4 letters of recommendation. All application materials, including letters of recommendation, must be submitted at the same time through AP Recruit at: https://aprecruit.ucr.edu/apply/JPF00336 . For more information about the position,please contact Dr. Laosheng Wu, Department of Environmental Sciences, University of California, Riverside (laosheng.wu@ucr.edu). For questions on application procedures and requirements, please contact Judy Bliss, Academic Personnel Coordinator, at judy.bliss@ucr.edu. Additional information about the Departments of Environmental Sciences can be found at: http://envisci.ucr.edu/. UCR is a world-class research university with an exceptionally diverse undergraduate student body. Its mission is explicitly linked to providing routes to educational success for underrepresented and first-generation college students. A commitment to this mission is a preferred qualification. Advancement through the faculty ranks at the University of California is through a series of structured, merit-based evaluations occurring every 2-3 years each of which includes substantial peer input. The University of California is an Equal Opportunity/Affirmative Action/Disability/Veterans Employer.

Student Opportunities

Two Postdoctoral Research positions are currently available in the Department of Earth and Environmental Science at the University of Pennsylvania.

We seek an individual with a strong background in mineralogical and microchemical characterization to study a variety of Earth materials, including rock fulgurites (melt, crystals, and associated deformation features caused by lightning strikes on rocks), airborne dust, and materials associated with frictional sliding of experimental and natural faults. Experience with light microscopy and various electron beam instruments, specifically SEM, ESEM and analytical TEM, is essential. Previous experience characterizing materials associated with environmental health issues (e.g., airborne particulates) is preferred but not required.

We seek another individual with experience in studying impact-induced melting and deformation in rocks to investigate rock fulgurites resulting from lightning strikes. The successful candidate will apply modeling, theoretical and/or experimental approaches to understanding the formation of fulgurites and associated shock microstructures, and will work closely with the post doc described above to inform models and theory with microstructural observations. A key goal will be to understand similarities and differences between shock-induced planar deformation features in fulgurites with similar features in rocks deformed by meteoric impacts or experimental shock loads.

Both positions are available for one year and may be renewable based on performance and the further availability of research funds.

Please send a letter of interest, CV, and the names and contact information of 3 references to Prof. Reto Gieré (giere@sas.upenn.edu). Interested candidates are encouraged to arrange for an interview at the upcoming Goldschmidt Conference. Evaluation of applications will begin immediately and continue until the position is filled. Penn is an affirmative action, equal opportunity employer.

3 Post-docs (Earth system scientist / physicist)
Potsdam Institute for Climate Impact Research (PIK), Germany

Subject to final approval by the Federal Ministry of Education and Research, the Potsdam Institute for Climate Impact Research is seeking to fill three temporary positions:
Post-doc 1 (ref. no. PalMod-1-1/3-A) will work on two tasks with our 3D Earth System Model. (i) Coupling of our continental ice sheet model (PISM-PIK) and (ii) performing and analyzing transient climate simulations from glacial conditions into the Holocene, with a focus on abrupt glacial events. - **Post-doc 2 (ref. no. PalMod-1-1/3-B)** will work on further development and improvement of the physical components of the Earth system model of intermediate complexity CLIMBER-2 with focus on coupling between ice sheets, atmosphere, land surface and ocean, simulations of the last glacial cycle to analyse the role of dust feedback in termination of glacial cycles. - **Post-doc 3 (ref. no. PalMod-2-1/2)** will work on further development and improvement of the marine carbon cycle components of the Earth system model of intermediate complexity CLIMBER-2 with the final aim to simulate CO_2 evolution during the last glacial termination.
Required are a doctorate and a proven track record in a relevant field, skills in physics and scientific computing, fluent written and oral skills in the English language and willingness to travel.
Detailed information concerning application requirements available at: **https://www.pik-potsdam.de/aktuelles/stellen/postdoc-positions/3-post-doc-positions**
Salary and benefits are according to public service regulations in Germany (E13 TV-L).
All applications should be sent by regular mail to: Potsdam Institute for Climate Impact Research, Prof. Stefan Rahmstorf, P.O. Box 60 12 03, D-14412 Potsdam, Germany

CMU
CENTRAL MICHIGAN UNIVERSITY

Two Tenure-Track Assistant Professors and a Full Professor Department Chair
Environmental Geosciences

The Department of Earth and Atmospheric Sciences (EAS) seeks candidates who use a combination of fieldwork, large data set analysis, and modeling to address environmental problems. Preference will be given to candidates with expertise in one or more of the following areas: biogeochemical cycling, stable isotope geochemistry, land/atmosphere interactions, sedimentology/geomorphology, the use of geophysical techniques in environmental research, and other areas of environmental science pertinent to the Great Lakes region.

Two Assistant Professors: Candidates should have a record of publishing in quality journals and have a commitment to excellence in undergraduate teaching and graduate education. Successful applicants will be expected to develop and maintain an externally funded research program. The initial teaching load will be 3 courses per academic year, for up to 5 years based on satisfactory progress towards establishing a funded research program.

Department Chairperson: Candidates should have an outstanding record of publishing and external funding as well as strong evidence of effective leadership in an academic setting. The successful applicant will be expected to develop and maintain an externally funded research program. The successful candidate will use a multidisciplinary approach to research, demonstrate excellent interpersonal and communication skills, provide a vision for strengthening the department, and oversee the launch of the environmental science program. Additional responsibilities include teaching 2 courses per academic year.

Review of applications begins September 15, 2015, and continues until the positions are filled. Applications must be submitted through **www.jobs.cmich.edu**

CMU is an AA/EO institution, providing equal opportunity to all persons, including minorities, females, veterans, and individuals with disabilities (see **www.cmich.edu/ocrie**).

NASA Goddard Space Flight Center

Earth Sciences Division

The Earth Sciences Division at NASA's Goddard Space Flight Center, in Greenbelt, Maryland, is soliciting statements of interest for full-time PhD level civil servant scientist positions for early career through senior levels, in the following areas:

Evapotranspiration Remote Sensing
We seek a scientist with expertise in remote sensing of evapotranspiration. Experience in thermal observation-based evapotranspiration estimation, microwave soil moisture retrieval, and vegetation stress assessment based on hyperspectral observations is highly desirable. The incumbent will be expected to apply these techniques for improving understanding of the water cycle and for direct societal benefit, and to contribute to the design and development of future Earth observing missions.

Snow Remote Sensing
We seek a scientist to develop advanced techniques for remote sensing of snow water equivalent. Experience in retrieving snow properties based on active and passive microwave, LIDAR, visible, and signal-of-opportunity (SoOp) observations is highly desirable. The incumbent will be expected to improve understanding of the global water cycle, to develop applications of direct societal benefit, and to participate in the design and development of future Earth observing missions.

Global Regional Ecosystem Modeling
We seek a scientist with expertise in ecosystem modeling to support studies of the global biosphere, biogeochemical cycling, and land-atmosphere interactions. Interested scientists should have experience developing and using diagnostic and/or prognostic ecosystem models to investigate the response of vegetation systems to climate variability, ecosystem disturbance, and human activities, and to better constrain carbon, water, and other biogeochemical fluxes. We seek an individual who will pursue hypothesis-driven research, and build next-generation capabilities by incorporating new remote sensing data sets to drive global and regional models and validate results. The position will interface with atmospheric and hydrologic modeling groups within GSFC, including the Global Modeling and Assimilation Office (GMAO).

Radiative Transfer
We seek a scientist with expertise in the design and development of line-by-line and multiple scattering radiative transfer models of solar and thermal radiation with application to terrestrial-type atmospheres. Specific experience in the use of numerical parameterizations (e.g., k-distributions) and analysis and interpretation of spectral and/or polarimetric measurements are highly desirable, as are interests in terrestrial climate, solar system planets, including exo-planet applications. Also highly desirable are programming skills in FORTRAN and/or similar computer languages.

Satellite Remote Sensing Scientist
We seek a senior/mid-career remote sensing scientist to provide science leadership and direction to the diverse group of civil servants and contractors in the Laboratory's atmospheric constituent remote sensing group. The incumbent will be expected to lead the ongoing retrieval of atmospheric constituents; maintenance and improvement of ongoing and development of new multi-decadal, multi-instrument data products; collaborate with ground-based observations to validate space-based observations; and collaborate with modeling groups to use the space-based observations to answer Earth System Science questions. A background in remote-sensing instruments and/or the retrieval of atmospheric constituents, trace gases and/or aerosols by satellite remote sensing is highly desirable.

Oceanographic Data Assimilation Scientist
We seek an ocean scientist to contribute to a major project in Earth System Data Assimilation, including leadership of the ocean group in the Global Modeling and Assimilation Office. The incumbent will be expected to lead advances in the data assimilation techniques for the ocean, in the context of using multiple satellite observations of the physical and biological ocean state in high-resolution computer models. Experience in more than one of the areas of high-resolution ocean modeling, high-performance computing, development of observation operators for complex ocean-observing instruments, and Kalman-filter assimilation techniques is essential. The incumbent will also be expected to liase closely with NASA and other science teams, in order to effectively support their missions, use their observations, and plan for future observational types.

Seasonal Prediction Scientist
We seek an Earth scientist with expertise in numerical modeling of physical processes to contribute to the continued development and refinement of the coupled GEOS-5 Earth System Model. The incumbent will be expected to lead research projects that isolate impacts of different forcing mechanisms on the sub-seasonal to seasonal time frame. The incumbent will contribute to the GMAO's participation in NASA current missions, including GPM and SMAP, and to the planning and execution of future missions. Experience is essential in studies of physical forcing processes in the Earth System, including cloud-aerosol-radiative forcing, polar processes, or tropical ocean-atmosphere coupling. Experience in numerical simulation using high-performance computing environments is essential.

The above positions are intended for civil servant hiring for U.S. citizens. A PhD or equivalent experience in Earth sciences or related discipline is highly desirable for all positions. Interested scientists should send a cover letter, curriculum vitae, statements of research interests and names and contact information for three professional references to Michele.r.ben-gera@nasa.gov by September 30, 2015. A subsequent job application process will be conducted through USAJOBS (www.usajobs.gov). NASA GSFC is an Equal Opportunity Employer.

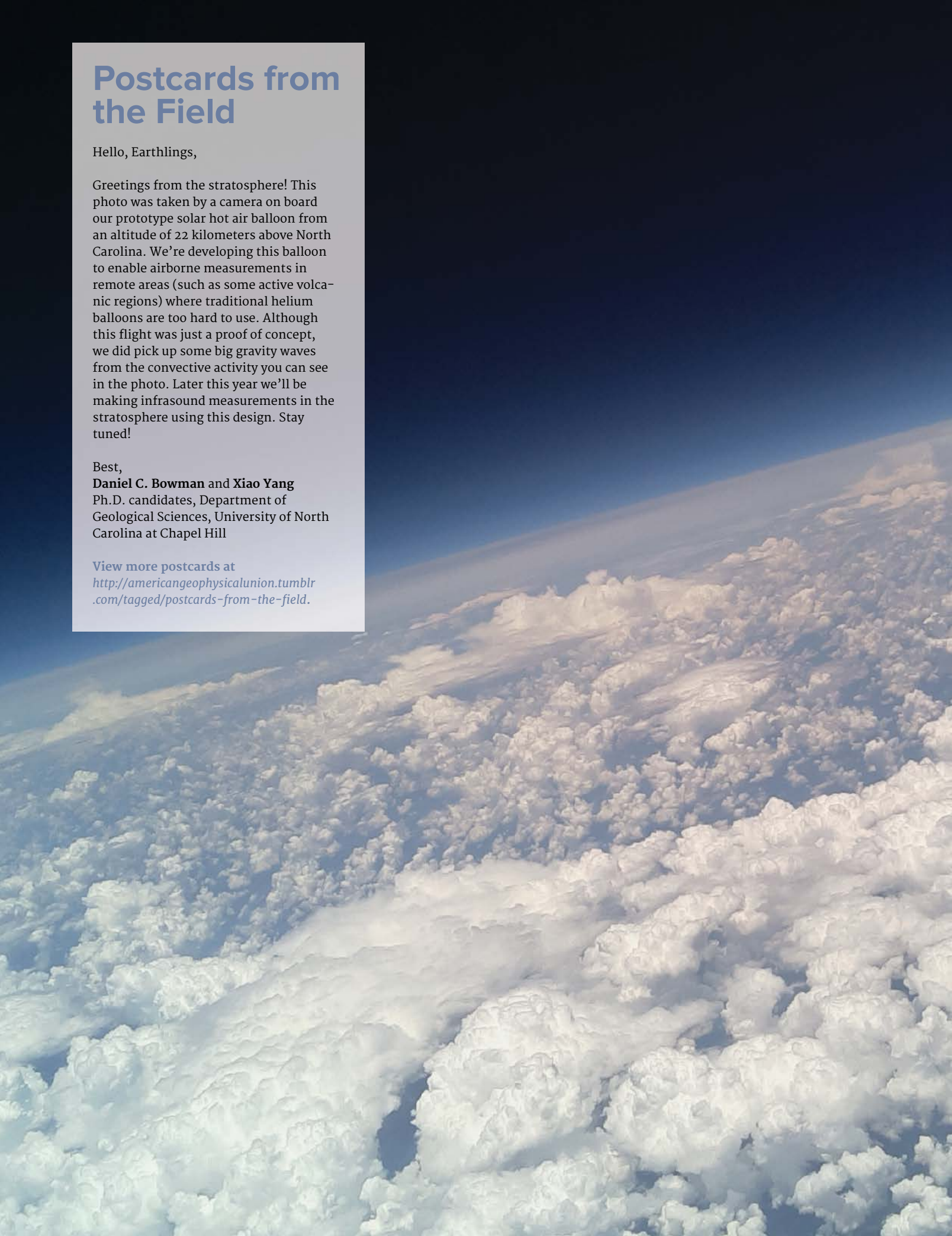
Postcards from the Field

Hello, Earthlings,

Greetings from the stratosphere! This photo was taken by a camera on board our prototype solar hot air balloon from an altitude of 22 kilometers above North Carolina. We're developing this balloon to enable airborne measurements in remote areas (such as some active volcanic regions) where traditional helium balloons are too hard to use. Although this flight was just a proof of concept, we did pick up some big gravity waves from the convective activity you can see in the photo. Later this year we'll be making infrasound measurements in the stratosphere using this design. Stay tuned!

Best,
Daniel C. Bowman and **Xiao Yang**
Ph.D. candidates, Department of Geological Sciences, University of North Carolina at Chapel Hill

View more postcards at
http://americangeophysicalunion.tumblr.com/tagged/postcards-from-the-field.



2016

OCEAN SCIENCES MEETING

21—26 February • New Orleans, Louisiana, USA

AGU • ASLO • The Oceanography Society

Submit an Abstract for Presentation

Abstract Submission Deadline:
23 September 2015

The theme for the 2016 Ocean Sciences Meeting is **Ocean Sciences at the Interface**. Complex interactions often occur at interfaces. Interactions at these interfaces occur on a wide range of spatial and temporal scales, and these interactions are critical for understanding the world around us and implementing informed policies in a global society. The meeting will highlight processes at interfaces and how the work at such interfaces pervades the study of ocean sciences and shapes the impact of our research on society.

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